BELL
TELEPHONE QUARTERLY

VOLUME XIX, 1940

INFORMATION DEPARTMENT
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BELL TELEPHONE QUARTERLY

A
Medium
of
Suggestion

A
Record
of
Progress

VOL. XIX JANUARY, 1940 NO. 1

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for the BELL SYSTEM by the INFORMATION DEPARTMENT of the
AMERICAN TELEPHONE AND TELEGRAPH COMPANY
195 Broadway, New York, N. Y.

"A CONTINENT IS BRIDGED"

Drawn by Franklin Booth for the observance of the twenty-fifth anniversary of transcontinental telephone service

A QUARTER-CENTURY OF TRANSCONTINENTAL TELEPHONE SERVICE

The Twenty-fifth Anniversary of the Public Opening of the First Telephone Line from Coast to Coast Recalls the History of that Pioneer Undertaking, and the Great Advances Since Then

INTRODUCTION

ON January 25, 1915, the first transcontinental telephone line was opened for public use. For the 3,400 miles of its cross-country march between New York and San Francisco, it consisted almost wholly of two physical circuits of heavy copper wire and one phantom circuit.

Today the number of circuits—physical and carrier-current—which cross mountains, plains, and deserts between East and West is about 170. They follow four geographically distinct routes. Over them speed many hundreds of messages each day. The service is accepted as a matter of course, and the plant which makes it possible is taken for granted. But it was the First Transcontinental which proved triumphantly that telephony could span the continent; that the ideal of universal service could become a reality.

That is why that date late in January of twenty-five years ago has so vital a significance today. That is why this issue of the QUARTERLY is devoted in such large part to a consideration of the event: of what led up to it and of what has come after; so that it may be seen as epochal, and so that there may be seen a progress and a growth in every phase of telephone service since then which has been as epoch-making as was that first conquest of the barriers to speech between the Atlantic and the Pacific.

The story of the First Transcontinental has never been told in full perspective. The Bell System publications which, a quarter-century ago, first reproduced a number of the illustrations shown here on later pages, are yellowed with time, and but a few thousand remain of the telephone men and women who thrilled then to read how the voices of Bell and Watson, of Vail and Carty and Woodrow Wilson and others, sped by wire across our land.

Indeed, of today's quarter of a million Bell System employees, perhaps ten per cent—perhaps a few more than that—were actively engaged in telephone work in 1915. To some of these, the articles which follow will have the deep interest of personal experience recalled. Others of them, reading of the events here related, will

THE FINAL POLE

On June 17, 1914, the last pole of the transcontinental line was placed at the Nevada-Utah state line and the wires were strung. The men in the picture, reading from left to right, are: C. R. Cole, Superintendent of Construction, Pacific Telephone and Telegraph Company; Mr. Putnam, Special Inspector, American Telephone and Telegraph Company; C. E. Fleager, Division Plant Engineer, Pacific Co.; W. T. Teague, Division Superintendent of Plant, Pacific Co.; D. P. Fullerton, General Superintendent of Plant, Pacific Co.; G. E. McCarn, General Superintendent of Plant, Mountain States Telephone and Telegraph Company; W. D. Staples, Division Superintendent of Plant, A. T. & T. Co.; E. F. Coyer, Mountain States Co.; C. C. Pratt, District Plant Superintendent, Mountain States Co.; H. W. Kline, Division Superintendent of Plant, Mountain States Co.

recollect with pride that they were a part of the organization when, twenty-five years ago, that new instrumentality of communication was dedicated to the Nation's service. It is principally to the more than 200,000 Bell System men and women who know only by hearsay of the building of the First Transcontinental, therefore, that the following articles are addressed.

Two of them have been prepared especially for this issue of the QUARTERLY; the third was delivered by Dr. Jewett as the Steinmetz Memorial Lecture before the Schenectady Section of the A. I. E. E. on November 2 under the title of "The Technical Significance of the First Transcontinental Telephone Line," and has been edited only so much as is necessary to prepare it for publication. Read in sequence, these three articles must convey a clear sense of the great contrast between the telephone art of the present and of twenty-five years ago.

In the implications of that contrast the men and women of the Bell System will take a special satisfaction; for there they will find new testimony to the traditional policy of the organization that each great accomplishment—and the first bridging of the country by voice was that—shall be but a stepping-stone to further progress in the service of the public.

I. THE LINE AND THE LABORATORY

Research Was Called Upon to Provide New Knowledge, New Equipment, New Techniques, Before Construction Could Be Undertaken to Close the Gap in the Westward Wires

By JOHN MILLS

In the history of telephony, a crucial date is the year 1911, when service was opened between New York and Denver. The geographical range had stretched from the two miles of Boston–Cambridgeport transmission in 1876, past the nine hundred represented by New York–Chicago in 1892, to the twenty-one hundred of New York–Denver service. The first war with attenuation was over; but it had ended in a drawn battle, for the engineers could not have advanced farther without new weapons.

Those extensions of telephonic range were each the result of engineering developments and inventions. In that regard they were unlike extensions of railroad lines, which can be accomplished through sufficient capital, labor, and determination. It was not enough to build longer lines: it was necessary to talk over longer stretches of wire. The Denver line utilized every technique and refinement of telephone engineering of its day. Practically, it represented the limit of distance for telephone communication.

The reason that a telephone line cannot be indefinitely extended, like a railroad line, lies in the fact that a railroad train carries its own fuel and develops *en route* the energy for its own travel, while the trains of electric waves which carry telephone messages start out with the energy given to them by the transmitter and when that is used up they are powerless to move farther. Just as a railroad train in its travel must overcome friction, so a telephone train of electric waves meets frictional resistance as it progresses along the line.

Along the route to Denver, the wave train would lose one-tenth of its initial energy in traversing the first sixty miles of line. The nine-tenths of the original energy available at the end of that stretch would suffer a corresponding percentage loss while traveling the next sixty miles. The speech wave-train was decimated every sixty miles by the attenuating effect of the line. What reached the receiver at the end of a long line was, therefore, only a small fraction of what started.

To start much more energy was impracticable, as was the use of a receiver which, through greater sensitivity, would respond to much smaller currents, because a certain minimum of received current was required to stand out above any small extraneous currents which might be induced in the line by currents in any neighboring lines along its route. The received current had also to be sufficient to reproduce speech loudly enough to be heard above the ordinary noise of home, or office, wherever the receiver was located. The solution did not lie in the terminal apparatus; it had to be found along the line itself.

Along the line, rather than in the line. In the construction and equipment of the Denver line, about all had been done which could be done to reduce the attenuation, or weakening, to which telephone currents would be subjected. The line was built of 8-gauge (B.w.g.) copper wire, weighing 870 pounds a loop mile. This was because large wires carry electricity with less frictional resistance than do small wires. There is analogy with pipes carrying fluids. The size of wire utilized was as large as engineering considerations and economics would admit.

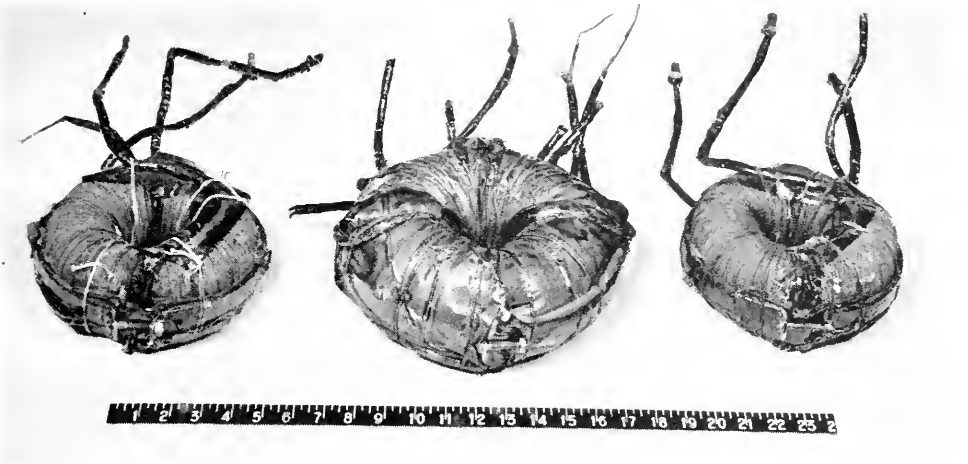
The Role of the Loading Coil in Long Circuits

Along the route, every eight miles, there was inserted in the line a large coil of wire with a magnetic core. These "loading coils," as they were called, although they did increase the length of wire through which the current had to pass *en route* to its terminal, served to make the line as a whole less highly attenuating than it would have been without them.

To fall for a moment into the phraseology of the electrical engineer, their presence increased the inductance of the line and thus offset, to a considerable degree, the effect of the capacitance of the line. Without defining these terms, it is enough to say that as a wave train travels along a line it encounters their effects, as well as that of electrical resistance. The amount of each depends upon the geometrical relationship of size of wires and separation between them. The percentage loss of energy which the wave suffers in each mile of travel depends in a complicated manner upon the magnitude of these three constants of the line structure, that is upon its resistance, capacitance and inductance per mile.

Capacitance is always present in a telephone line, but inductance may be negligible, as it is in cable, where the wires of a pair are close together. Since inductance and capacitance counteract each other to some extent, the absence of inductance in a cable circuit means that its capacitance is completely unmitigated. In open wire circuits, where the separation between the wires is usually twelve inches, the condition is much more favorable to transmission. The attenuation is correspondingly less, for the same size of conductor, but not as small as it would be if the inductance were large enough to offset the effect of capacitance.

That fact had long been recognized, but it didn't help the telephone engineer much, because he had no convenient way of increasing the inductance of a given telephone line. What he would have liked would have been insulated wires in a medium



AIR GAP LOADING COILS

Developed for the first transcontinental line. The large coil is for loading the phantom circuit, the small coils for loading the side circuits

more magnetic than free air, for then the inductance would have been markedly greater. That was difficult of accomplishment, although years later it became practicable with the development of permalloy, when in a submarine cable the inductance of the circuit was increased by wrapping the conductor with a thin tape of that magnetic alloy.

An obvious way of increasing the inductance of a telephone line, with the hope of gaining reduced attenuation, was to connect coils of wire—wire has more inductance coiled than straight—into the line every so often. If the coils had cores of iron, their inductance would be still higher. That was tried at times, but failed lamentably. The reason we now know to have been lack of knowledge as to the correct spatial separation of the coils along the line.

Some idea of all this had been adumbrated in the mathematical papers of Oliver Heaviside, an English genius whose expositions were not always easy reading. What was needed was a practicable engineering formula which could be applied to the construction of a telephone line.

This problem was attacked by more than one engineer, and two arrived at satisfactory solutions. One was Michael I. Pupin, who, about 1900, showed that the desired effect could be obtained if the coils were inserted at certain regular intervals along the line. The other scientist who solved the problem was George A. Campbell, a member of the technical staff of the American Bell Telephone Company in Boston. What these two men made independently was a basic invention for telephone lines, just as Bell had earlier made the basic invention for the terminal apparatus of telephony. To which of them, however, belonged the patent was only to be decided by a long court struggle, won by Professor Pupin, who sold rights to the American Bell Telephone Company.

MECHANICAL REPEATER, 1906
Early Shreeve Type

After this invention there remained to be solved many problems in the design and construction of loading coils, many researches to be conducted, and further invention. In this continuing work the practical formulae of Dr. Campbell proved most important. When properly designed loading coils were spaced approximately eight miles apart along an open-wire telephone line, its transmission efficiency was just about doubled. The effect of attenuation was halved and there was possible the same grade of telephonic transmission as in a non-loaded line half as long. That was about as much gain as could well be expected from loading, but it made telephony possible over the New York-Denver stretch.

Loading, besides presenting innumerable problems of its own, introduced others which required expert attention. One of these was the insulation of the line wires on their poles. New types of insulators and new procedures had to be developed, because in effect a loaded line worked at a higher voltage than did a non-loaded line, and there was a greater tendency for current to leak from the wires to the ground, particularly on rainy days. The problem took an acute form some years later when the line was extended west from Denver past Great Salt Lake. There, the windblown salt spray had a serious effect on insulation, and considerable special engineering work and maintenance was required in that section of the transcontinental line.

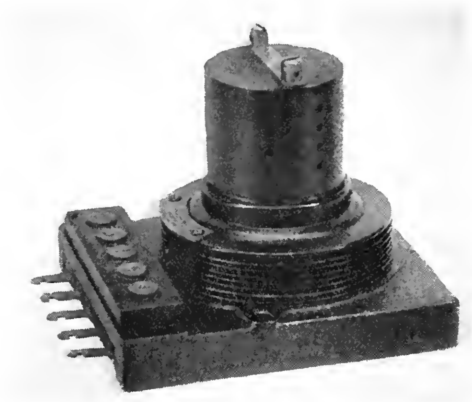
The Development of the Mechanical Repeater

WITH the introduction of loading and the development of coils excellent from the standpoint of that day—although not so small, efficient, and inexpensive as those of today—the engineers had done about all they could to the line itself to increase the range of telephony. Any advance, it was then obvious, must come from developments along the line. In that regard there was an analogy between telephony and the earlier art of telegraphy. The coded signals of telegraphy, initiated by a key which connected a battery to the line, and interpreted by a sounder at the receiving end, were also limited in the distance they could effectively travel. To extend their range, so-called telegraph repeaters had been developed. These were relatively simple devices in which the moving member of the sounder, instead of merely clacking against a stop, was arranged to operate a switch, connecting a battery to the next section of line and, consequently, sending along that line a new signal similar to that which was received.

Much effort had been spent upon the development of a telephone repeater which would receive the telephone current from a distant transmitter and initiate, in another transmitter, a replica of that current to travel on to a more distant receiver. The problem was fraught with difficulties, because the telephone current was much more complicated than the telegraph current and involved a much wider range of vibration frequencies.

Many attempts were made to combine receiver and transmitter into a telephone repeater. With one exception these were essentially fruitless. The exception was a mechanical repeater invented by Herbert E. Shreeve of the American Bell Telephone Company and later of the Engineering Department of the Western Electric Company. This device had a fairly successful test in 1904 on a telephone circuit between Amesbury, Massachusetts, and Boston, where its introduction resulted in greater intelligibility in the transmission than could be obtained over the line without the repeater.

THE device went through a number of forms in the hands of Shreeve, R. L. Jones, and their associates; and it served with considerable success in certain situations. Inherently, however, it had a number of defects. One was its disproportionately smaller sensitiveness when the incoming telephone current was very small. For that reason, although it might work in a telephone line over which two persons were speaking loudly, it might be almost useless in a long line when the speakers had weak voices. Its chief defect, however, was a lack of fidelity in recreating the telephone current: it had a tendency to favor some pitches, or tones, of voice and to discriminate against others. That, added to its tendency to give greater amplification to the stronger tone, meant a certain inexactness in its copy of the telephone current. The effect was not so bad if only one repeater was in the line between the parties conversing; but on a long line, where several repeaters in succession had to be installed, speech might be distorted into unintelligibility.



MECHANICAL REPEATER, 1912

Final cartridge type

Each successive model of the device, however, showed distinct improvement over its predecessor, and, in time, particularly with the application of more modern knowledge as to mechanical vibrating systems, it would have served more widely, had not other types of repeaters been developed.

Aside from the defects which it had, it was charged with incapabilities for which it was not itself to blame. It failed almost completely when connected into loaded lines. The difficulty arose in part from expecting the repeater to adapt itself to the line, when what was required was some adaptation on the part of the line to the use of repeaters. The necessary techniques were developed later in connection with the first transcontinental line. As a matter of fact, the Shreeve repeater was successfully used in commercial service for a few days in 1915 over the transcontinental line, in which it had been installed for that purpose at Pittsburgh, Omaha, and Salt Lake City.

Organizing the Research for a Practical Repeater

THAT New York–Denver would be the practical limit of distance for telephony unless the problem of telephone repeaters could be satisfactorily solved was recognized several years before that line was ready for service. Concentrated attention to the problem was proposed by J. J. Carty, then Chief Engineer of the American Telephone and Telegraph Company, and approved by its then president, Theodore N. Vail. Carty asked for more men and dollars to apply to the project of the development, by further research, of a telephone repeater suitable to operation on long loaded lines. It is interesting to note, however, that his memorandum on this subject went further and pointed out that the problem of long distance radio telephony might also expect solution as a result of the development of a satisfactory telephone repeater.

Starting in the winter of 1910–11, a small group of scientists was selected and research initiated under the general guidance of Dr. F. B. Jewett, who was then Transmission and Protection Engineer of the American Telephone and Telegraph Company. The men who were to investigate the problems which loaded lines presented to repeaters were in Dr. Jewett's department in the telephone company; those who were to make a laboratory attack on the repeater itself were grouped into a research department under Dr. E. H. Colpitts in the Engineering Department of the Western Electric Company. The scientists thus assembled became the nucleus of the present Research Department of Bell Telephone Laboratories. A year later Jewett became Assistant Chief Engineer of the Western Electric Company, and in that position coördinated the entire transcontinental line research, whether carried out in the laboratory or in the field.

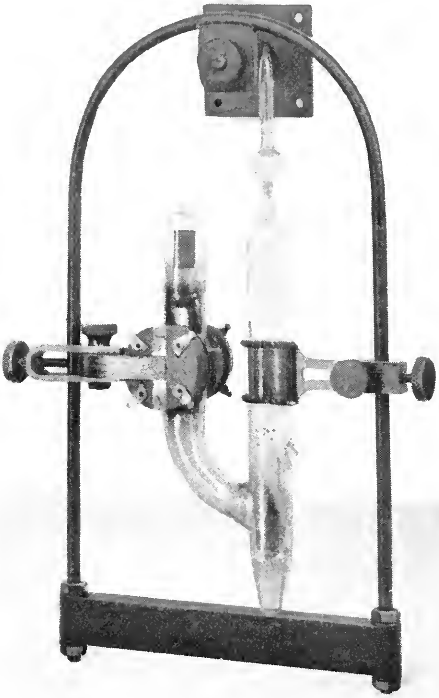
THERE was a third phase to the repeater problem. It was not enough that lines should be adapted to repeaters and that repeaters should be developed which would be effective and distortionless in their operation; there were also necessary suitable circuit arrangements for the introduction of repeaters into the lines. This was well recognized by all those concerned and was a project to which both groups contributed.

The difficulties of the mechanical type of repeater were due in part to inertia, which is inherent in any mechanical device. The diaphragm of its receiver portion had to vibrate at any and all the frequencies involved in the speech wave and at the same time drive at the same vibration rates the movable electrode of the carbon button transmitter. The inertia effects were recognized by Jewett and his associates, who looked for moving parts of lighter weight. Instead of vibrating diaphragms they considered the possibility of electrified molecules of gas or even of free electrons—the tiny parts of atoms which science had recently recognized.

FIRST among the scientists enlisted in the research group was the late Dr. H. D. Arnold, who had had his training under Professor R. A. Millikan at the University of Chicago and was most highly recommended by him. Arnold first turned his attention to the development of a repeater which would utilize gas molecules.

He set up a tube in which there was an electrical discharge current carried by a stream of electrified—that is, ionized—molecules of mercury vapor. Then he arranged to wobble that stream sidewise through the magnetic action of a telephone current in a coil essentially similar to that of a telephone receiver. In the tube he placed two metal plates or electrodes. To these he connected a battery and a transformer in such a way as to form a transmitter the movable constituents of which were ionized molecules of gas instead of carbon grains. If there was no current in the receiver coil, then the arc stream flowed steadily and was undeflected, and there was no current from the transmitter. When the arc stream was vibrated by an incoming telephone current, there was produced an outgoing current of similar vibrations, but of a magnitude greatly increased because of the power available in the battery.

That ingenious mercury-arc repeater was capable of good amplification, but it had a serious tendency to be noisy in a way somewhat similar to that of an old-style carbon transmitter when it "burned" and "sizzled." It was tried out experimentally on telephone lines, but it was used only under special engineering supervision, and never for any length of time. Development work on it was dropped early because of the much greater promise of another device.



MERCURY ARC REPEATER TUBE, 1912

The development of the late H. D. Arnold

This was the audion of Dr. Lee De-Forest, one of the most interesting and important inventions in modern electrical arts. Although at that time a very crude instrument, incapable of being used immediately as a repeater in the telephone plant, its possibilities

DeForest Detector, 1908
Side view of the single plate audion

were recognized by Jewett, Colpitts, and Arnold, and a program of research was undertaken, directed towards its development and application as a telephone amplifier.

The Genesis of the Vacuum Tube Repeater

In its grosser elements the 1908 audion of DeForest is the vacuum tube of today, utilized in millions of radio receivers, in hundreds of thousands in the telephone plant and in thousands by the motion picture industry. From a device capable of handling only a watt or less, it has been developed into forms capable of controlling a hundred or more kilowatts. When the audion was invented, the electron which is its active agent was practically unknown; and its development into the versatile vacuum tube of today followed, but also contributed importantly to, the modern physics of electronics.

The audion was a small glass bulb, evacuated according to the manufacturing techniques of its day. To its partial vacuum the electrical entrance was through four sealed-in wires. Between two of these was a lamp filament which could be heated to a bright red by connection to a battery. The third wire ended in a metal plate parallel to the inverted V-shaped filament. The fourth connected to a grid of wires located between filament and plate.

The action is to be described in terms of electrons. The current which heats the filament is a pellmell stream of electrons, and some of them get going so fast as to break completely away from the filament and issue into the surrounding space. Technically speaking, there is a thermionic emission of electrons. Within the evacuated tube there is, therefore, an atmosphere of electrons; in their motion some will find their way back to the filament, strike into it and take up their former activities as current carriers. For any definite temperature of filament a state of equilibrium is quickly attained with about as many returning each moment as leave the filament.

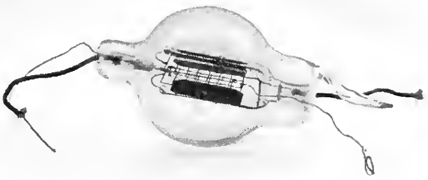
When the plate is made positive with reference to the filament, by connecting a battery between them, the equilibrium is upset and the electron atmosphere is drawn toward the plate. There is then a stream of electrons from filament to plate and back to filament through the wires of the battery circuit. If the battery is reversed, the plate repels electrons and there is no current in the filament-plate circuit.

That one-way conductivity of the filament-plate circuit of a vacuum tube had been recognized, but not applied, by Edison years before DeForest. It had been applied by Fleming, an English radio experimenter, in a radio detector. To the high-frequency currents of a receiving radio antenna the filament-plate circuit would offer conduction for alternate halves of the waves only, acting like a valve and rectifying the alternating current so that its signal-bearing variations could be heard in a telephone receiver.

DeForest's contribution was the wire grid which allowed another current path through the tube: a path from filament to grid, which is of tremendous value because the strategically-placed grid can exert a sensitive control on the electron stream in the plate circuit. As DeForest used his three-element tube, the alternating electromotive force derived from a receiving antenna was applied between grid and filament. A telephone receiver and battery were connected between plate and filament. When modulated radio waves were received, the current in the receiver varied in correspondence with the speech or telegraph modulation.

SUCH was the audion which the agents of DeForest offered to the American Telephone and Telegraph Company in 1912. It was suggested that it could serve as an amplifying element in a repeater circuit. An incoming speech current was to be fed into its grid-filament path and an output current obtained from its plate-filament circuit, using a local battery as a source of energy. (Another battery heated the filament.)

The audion was tested, and it was found that under laboratory conditions it could amplify weak telephone currents supplied to it over quiet artificial lines. Actual lines, however, are inevitably noisy—that is, carry some extraneous currents—and speech currents must never be allowed to fall too low, lest they be obscured by noise currents. Telephone currents, although themselves small, are on the average much larger than the very feeble radio currents with which the audion had previously dealt. And it was found that when the audion was called upon to handle the typical value of current which might be expected at a telephone repeater station it would fill with blue haze, seem to choke, and then transmit no further speech until the incoming current had been greatly reduced.



EARLY HIGH-VACUUM REPEATER

First type, used at Philadelphia in commercial telephone service, 1913; made by Western Electric Company

The explanation came from the researches of Arnold, to whom in the meantime the device had been turned over for investigation. Arnold recognized instantly its inherent possibilities and the cause of its incapacities. Instead of looking at it as did radio engineers, to whom it had been for years a familiar device, he considered it as a specific instance of the general problem of conduction of electricity through vacua. The control which the grid exerted on the current between filament and plate was effective only when the electromotive force it applied was relatively small. When too large, the stream got out of control and increased without regard to the electrical status of the grid; a blue haze then filled the tube.

Arnold recognized at once, because of his basic knowledge of the infant science of electronics, that when the stream was controllable, it was a stream of electrons; but when it disallowed the authority of the grid, it was because ionized molecules of gas were taking part in the performance. To permit stability of operation and accurate control, the current through the tube must comprise only electrons. The audion, as was, contained too much gas—mostly plain air. A higher vacuum was necessary, and one of his tasks was to apply and to extend the latest techniques for producing high vacua.

THE blue haze occurred if gaseous molecules were present in too great density and if the electromotive force applied—the combined force of the battery in the plate circuit and the e.m.f. (electromotive force) in the grid circuit—was large enough to give the electrons, in their travel toward the plate, speeds high enough to do real injury to the gas molecules with which they collided. In such a case an electron impact will dislodge one of the electrons of a gas molecule, and two electrons will then have freedom where only one had it before. The original electron will continue its journey toward the plate, and the one it has manumitted will also start off in the same direction. Both may pick up speeds to do further damage, and the current is thus automatically increased by these "ionizing" collisions.

The blue haze which is the evidence of such spontaneous ionization is accounted for by recombinations, in collision, of electrons and ionized atoms—that is, those which have lost electrons and are therefore electrically compelled to move counter to the electron stream. Improving the vacuum decreased the chance of collisions, whether of ionization or of recombination, and ensured that the filament-plate stream should be purely electronic.

When it is electronic its strength, other things being equal, is delicately determined by the e.m.f. impressed on the grid circuit. The grid is strategically placed much closer to the filament than is the plate. A small change in the e.m.f. applied to the grid produces, therefore, as much effect as would one several times as large applied to the plate. How much more effective a fraction of a volt may be, in altering the intensity of the electron stream, when applied to the grid instead of the plate, is a matter largely of the spatial arrangements of the three electrodes within the tube. Those relationships Arnold studied; and on their basis he redesigned the audion to make the first three-electrode high-vacuum thermionic tube. That tube became the amplifying element of the telephone repeaters in the first transcontinental line.

Incidentally, Arnold and his associates, who included O. E. Buckley, H. J. van der Bijl, and W. Wilson, also constructed a year later much larger and more powerful tubes—tubes in which the grid could control an electron stream of more power. Using them, the Bell System inaugurated its program of radio development, the first epoch of which was the transatlantic transmission in 1915 of a few words from Arlington, Virginia, to Paris. That, however, is another story.

So also is the patent litigation which arose around this development of a high-vacuum audion. At the time Arnold, himself, did not feel that his decisive improvement in vacuum of the DeForest audion constituted an invention. It was some time later, when it was learned that a scientist in another industrial laboratory, Dr. Irving Langmuir of the General Electric Company, had applied for a patent on that score, that the contest began. It was carried through all the possible authorities, from patent examiners to the United States Supreme Court. This final authority decided that invention was not involved; but it added in its decision the statement that, if it had been, the invention would have been Arnold's.

The audion was invented. The vacuum tube was developed by methods of pure science which were brought to its study in the spirit of research.

The Problem of Loading Coils in Circuit with Repeaters

WHILE these promising developments had been under way in the laboratory under Dr. Colpitts' general oversight, other members of Dr. Jewett's force had concentrated on the very serious problems presented by loaded telephone lines. Experience with the mechanical repeater on loaded lines had shown that little amplification—too little to be practical—could be obtained by its introduction on such lines. If a repeater was adjusted to give more than a minimum of transmission gain, it sang—or, more accurately, it howled with discordant screeching.

The reason was inherent in the reciprocal nature of conversation and in the corresponding utilization of a single pair of wires as a medium for two-way transmission. A repeater, near the middle of a line, was expected to react to speech current from either direction and to send out instantly an amplified reproduction of that current. Since the repeater was incapable of determining from which direction the speech was coming, its transmitter attempted to distribute amplified current impartially in both directions.

If it could do so, all was well; but if it could not, its receiver got more current from one direction than from the other. To the excess which it received it responded exactly as to a speech current from a distant terminal. Its output was an amplified version of that input. But that output, in turn, failed to divide equally, and supplied a further excess to the receiver. The process was cumulative, and the repeater was soon buzzing along on its own, without regard to whether there was any conversation or not. The current it sent out was that of a tone determined by its electrical or mechanical preferences as to vibration rates: in other words, it "sang" at its own natural frequency.

The more efficient the repeater was, that is, the greater the ratio of the current it emitted to that which it had received, the more it would tend to sing, for any situation in which it was placed. Of course, if it didn't amplify at all there was no possibility of singing, so that one cure was to decrease its efficiency as an amplifier.

The other way was to use the repeater in situations where it was easier for it to avoid singing because its output current divided more evenly between the lines on either side of itself. Ordinary non-loaded lines, particularly if they were very long on either side of the repeater station so that any difference in their terminal conditions was minimized, were rather favorable to repeater operation; but the trouble was that when they were favorable they might be so long that the repeater heard so little it was licked to start with. For the repeater to be useful, the lines on either side of it had to offer approximately similar absorption for its output current—that is, technically, have equal impedances. The more nearly similar the lines, the greater the amplification which the repeater could give, as G. A. Campbell showed precisely by a mathematical analysis made during the early days of the transcontinental line project.

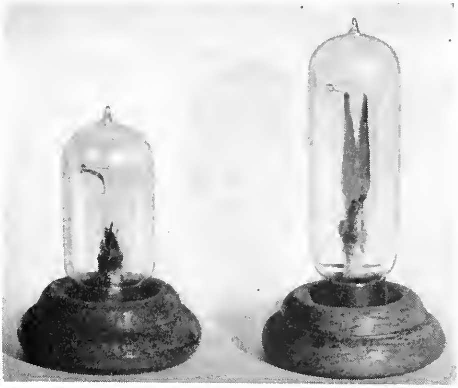
THAT loaded lines were unsuited to repeater operation had been proved by experience. Scores of loaded circuits in the New York–Philadelphia cable had been measured by R. S. Hoyt both ways from their midpoint at Penn's Neck. In each case he had measured their impedances to currents at a large enough number of different frequencies, in the range they could transmit, to get a complete picture of their impedance-frequency characteristics. And no two of them looked anywhere near alike. Since the transcontinental line would have to be formed by open wire, Hoyt and John Mills were given the task of investigating loaded open-wire lines and, if possible, of learning how to adapt them to repeater operation. Besides Hoyt's experience, they had the advantage of frequent consultations with two senior members of the Transmission Department, Otto B. Blackwell and C. A. Robinson.

Their work centered on Morrell Park, the open-wire terminal at Chicago, where there was available the largest number of loaded lines. Again the tests showed no two lines with suitably equal impedances. When they brought their curve-plotted data back to New York, after measuring all the available lines, there was one curve which fascinated Mills, who was a complete novice at telephone transmission just recruited from college teaching and shipped to the field for nights of testing with hardly an idea of how a long-distance telephone line looked anyway. The graph was a wavy curve with several large ups and downs, recurring almost regularly as the frequency of the test current was increased.

IT was such a satisfying picture of regularity, as compared to the more-than-stock-market-graph irregularities of all the rest, that he persisted in drawing attention to it and urging its study. Calling it to Hoyt's attention one day, by its route and pair number, he was overheard by Robinson, who immediately asked if the "office loading coil had been in circuit." An intermediate office on that route came practically at a loading point; and when the line was used for through service, rather than terminating, the coil was supposed to be cut in. Blackwell, in turn overhearing this question—for all four, along with H. S. Osborne, shared a common office—brought his theoretical background to the problem. Curves were laboriously calculated for a hypothetical line, with and without a missing coil at that given distance away; the regularity of the wave-shaped graph was unmistakeably due to the loading irregularity of a missing coil. A formula was obtained for estimating distances to loading irregularities, and Hoyt and Mills went back to their tests to see how smooth and similar they could make the impedance-frequency characteristics of loaded lines.

To get convenient quantitative relationships between loading irregularities and impedance irregularities, they also set up a long loaded artificial cable in the Research Laboratory at 463 West Street. With this they obtained whole families of graphs covering all sorts of carefully controlled conditions, including single and multiple irregularities. (Incidentally, all the measurements used as a current source the Vreeland oscillator, a mercury arc device which served excellently in the audio-frequency range before the vacuum-tube oscillator was developed; and it is here tardily given the hand it deserves). These measurements were soon to pay excellent dividends; but in the meantime the work had struck a snag.

A particular open-wire loaded line did not always have the same characteristic two nights in succession. Plant reports showed no trouble from lightning; no coils had been strapped out; and yet the line showed a different—and always unanalysable—mess of small loading irregularities. Large ones, of course, were easily located and corrected. Through the further coöperation of the Long Lines Department, whose wire plant out of Morrell Park was already a widespread laboratory, Mills was allowed to undertake a periodic examination of individual loading coils on the Newtown Square–Pittsburgh lead. The coils were connected by Fahnstock clips so they could be disconnected from the line wires and attached to portable measuring equipment which determined their inductance.



FLEMING VALVES

Two-element tubes used in wireless before the audion

ALL one summer a group of young men, assisting W. N. Rorer, rode that line, each man measuring the coils along his section and retracing his path to test them again. Only rarely did two successive measurements on different days agree. The inductance of a coil varied as much sometimes as it would under laboratory conditions if shot with two or three amperes of direct current. It was almost inconceivable that the high-voltage lightning could produce an equivalent effect without wrecking the coil. There was no discernible effect of lightning; and a coil which one day was seriously low in its inductance might be back almost to its nominal value on a succeeding day. But there was no other cause to assign. And proof of it came when Osborne, who was in California on other work, tested the coils along a lightning-free route and reported all of them within factory limits of their nominal values.

That put the problem squarely up to the coil designers, and T. Shaw, downtown,* and W. Fondiller with his associates, uptown,† went to work. Greater magnetic stability was required in the iron cores of loading coils. Air cores were proposed for a time but, in default of the present day methods of iron dust cores to which this work was preliminary, a proximate solution was found in segmented cores with intervening air gaps. New coils had to be designed on that basis, tested for approval, pots designed to hold them, and manufacturing methods established. In that work many men were creatively concerned whose numerous identities are passed over and inadequately credited by the brief statement that the Physical Laboratory and the Manufacturing Department of the Western Electric Company did the job in their usual competent manner.

For its day, what the coil designers promised was a remarkably efficient and stable coil. It underwent tests which showed it would stand up in the field, maintaining values within reasonably narrow limits of its manufactured condition. But there was still a range of values which any coil might have, rather than some single very definite value, and hence as many sources of irregularity along a line as there were coils en route. Assuming this range of irregularity, and utilizing the experimental data on the effect of multiple irregularities which had been carefully collated by Hoyt, Mills made a probability study of the irregularities in line impedance which might be expected from a multiplicity of small irregularities in coil inductance and in coil spacing—for the spacing on many existing lines was only approximately regular. In grinding the mathematical crank that transformed his premises into conclusions, he had the very necessary assistance of E. C. Molina, the pioneer probability expert of the Bell System. The conclusions did not indicate as happy a probable state of affairs as could be wished.

In a memorandum, to be published years later in his collected works, Campbell had analyzed the telephone repeater circuit and had related possible repeater gain to the impedance differences between the lines on either side of it. Combining the results of that analysis with the existing small amount of data as to gains obtained with mechanical repeaters on lines of more or less accurately known impedances, Mills had obtained a cruder empirical relation which specified in the units of that day—which knew not the euphonious decibel—the possible repeater gain for any given per-

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* A. T. & T. Co., 195 Broadway.

† Western Electric Co. Engineering Dept., 463 West St.

centage difference between the impedance-frequency characteristics of its associated lines.

That formula, combined with the probability study, showed too small a chance—even with the proposed new coils and with spacing accurate to half an ordinary pole span. The little irregularities might add up to too large a total effect. But there was a saving possibility emphasized in Campbell's memorandum. The circuit hitherto employed used one amplifying element and sent its current two ways. It was a two-way one-element repeater—a 21-type repeater, to use the terminology later adopted. Campbell pointed out the advantages of the previously known but not used 22-type repeater *; one in which two similar repeater circuits were used and two artificial lines. The lines which entered a repeater station, in that scheme, were not to be connected together by a repeater circuit. Instead, each line was joined by a repeater circuit to a dummy line; then the transmitters of the two amplifying elements were crisscrossed in connection so that each element fed its outgoing current to the line and the artificial line which were associated with the other repeater circuit.

The Balancing Network Proves to be the Solution

In this circuit it didn't make any difference how unlike in impedance were the two lengths of actual line; what was important was how closely each line was simulated in impedance by the artificial line which balanced it. If each of the lines on the two sides of a station were perfectly balanced by dummies (or networks), even though the two lines were of unequal impedance, any current transmitted through the repeater in one direction would divide with perfect equality between the line and its network, with the result that no current could flow back through the repeater in the other direction. Of course, perfect balance is impossible; nevertheless, this two-way two-element circuit provided the margin necessary to make transcontinental telephony possible. The trouble was that a loaded artificial line would be bulky,

VACUUM TUBE REPEATER, 1914

This was the vacuum tube repeater element used in the test conversations between New York and San Francisco

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* Invented by W. L. Richards of the American Bell Telephone Company.

very expensive to build, and two would be required at each repeater station.

Telling Hoyt his pessimistic conviction, Mills stated his conclusion that the only solution was to use the 22-type circuit, and he asked Hoyt's opinion on the feasibility of some suitable dummy line. Hoyt got out the family of curves on loaded circuits and almost immediately announced that a simple network could be made to simulate a loaded line if it terminated at a particular point in a loading section. Building out that network to any other fraction of a section was equally simple.

With Hoyt's invention of the first balancing network for a loaded line, the problem of adapting such lines to repeater operations was as good as solved; all that remained was plenty of hard work for all concerned, and some occasional ingenuity, in adapting old lines or building new ones. At the Laboratories, B. W. Kendall, R. C. Mathes, and W. L. Casper set to work on engineering the 22-type circuit with its necessary transformers; Hoyt devoted himself to network design; Arnold made improved vacuum tubes, using a filament constructed by A. M. Nicolson which was extremely efficient in emitting electrons; Mills with several associates tested and adapted lines; Robinson and A. B. Clark worried over the insulation problems at Great Salt Lake; and everybody was more than busy.

Summarizing the progress which had been made, Jewett could assure Carty that the project would be completed. A desired date had already been set by Carty and a condition added which, while very severe, introduced some amusing interludes. Carty insisted that no through test should be made on the line and that Vail should say the first words which traversed its entire length.

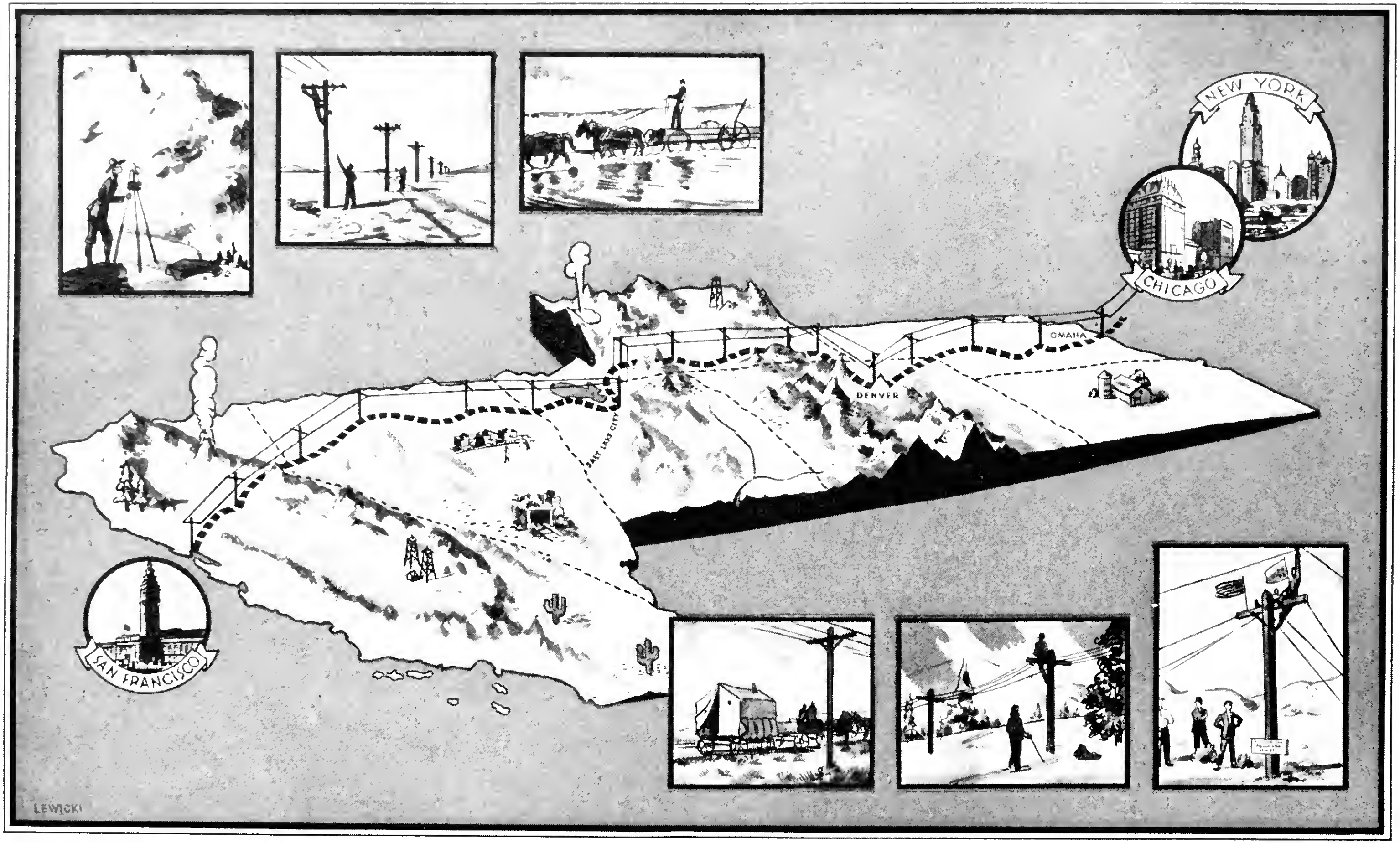
As a testing ground for all the new repeaters—the latest model of the mechanical, the mercury-arc, and the redesigned high-vacuum form of the audion—Philadelphia was chosen, because of the loaded circuits available in the New York–Washington cable. Shreeve and Mills, with the coöperation which they had learned to expect from the Long Lines Department, rented a room in the Bourse Building and ran leads to the test board on the floor above. And in that room Colpitts, Arnold, Kendall, E. O. Scriven, W. N. Thompson and others of the group worked many nights studying repeater operation on circuits withdrawn temporarily for that purpose from commercial service.

During March of 1914, when a severe storm took out many lines from Washington south, Shreeve's prompt action put this repeater room to good use. When early reports of the storm's extent began to reach New York, he sensed the situation and knew that without repeaters at Philadelphia the underground cable couldn't replace the long-haul open-wire circuits. So he telephoned Jewett, caught the next train, opened up the room, and put five repeatered circuits into the Plant Department's emergency service.

In the meantime, the Long Lines Department and the Pacific Telephone and Telegraph Company were solving their construction problems, installing at very regular intervals the huge pots containing three loading coils—two for side circuits and one for the phantom of the four wires—placing an improved design of insulators, and building a world-famous telephone line. At Pittsburgh, Chicago, Omaha, Denver, Salt Lake City, and the previously little-known town of Winnemucca, Nevada, special test rooms were set up and vacuum tube and mechanical repeaters installed. This work all went on under the personal supervision of Colpitts, who was usually to be found at the point where the need was most pressing. Shreeve and Kendall, installing repeaters, and Mills, clearing lines, with Colpitts not only as boss but sometimes as mediator between the claims, or claimed defects, of lines and repeater circuits, sweated west during the late spring and early summer of 1914.

Because of a proposed absence of Vail in the late summer, Carty had advanced the date on which he wanted the first through conversation for engineering tests; and July 29th was the goal. In the repeater room at Salt Lake City a switch had been put in the line, and definite orders were given to O. A. Pawlick that it should not be closed until time came for Vail's conversation with President G. E. McFarland of the Pacific Telephone and Telegraph Company at San Francisco. To officiate at the time, Shreeve had been sent to San Francisco. When the time came, he had a short circuit across the transmitter at which McFarland sat; and not until he had heard Vail's voice in his monitoring receiver did he cut it with the pliers he had provided for that purpose. Like an unveiling ceremony, when the cords are drawn or cut, the line opened to the telephone executives on opposite sides of the continent.

That is the technical history of the first transcontinental line as one man saw it and remembers it. Obviously an incomplete story, it offers its apologies for omissions of names and accomplishments. Only an article many times longer could do justice to that development, and for that the existing records are too meager. Documentary research would not yield its complete story. Much of it would have to come from the memories of Jewett and of Colpitts. Arnold, the third of those most responsible for the achievement, is dead; but his technical contributions have left a profound and continuing effect on all the communication arts.



WESTWARD THE COURSE OF SERVICE

The third dimension of this sketch-map gives some conception of the terrain across which the first transcontinental telephone line was built as it reached out from Denver to the Coast

II. THE CIRCUITS GO UP

Construction Completed Despite Nature's Obstacles, Impressive Ceremonies Gave Notice to the World that the First Telephone Line from Coast to Coast Was a Working Success

By H. H. NANCE and R. M. ORAM

THE building of the first transcontinental telephone line was not a single project in the same sense as was the Panama Canal. While there had been a steady progression of the country's telephone system westward from the Atlantic shore, it had been a succession of steps, each attaining to a definite goal, and each linking the telephone's newest frontier with the East. Moreover, each step represented about the maximum extension which was practicable at that stage of the art of telephony.

We can be fairly certain that the idea of coast-to-coast service was in the minds of telephone men for many years. For one thing, we can go back to the American Telephone and Telegraph Company's charter, issued in 1885, and find the incorporators talking about service to "each and every other of the United States, and . . . the rest of the known world." And when J. J. Carty, then A. T. & T. Chief Engineer, visited San Francisco with F. B. Jewett and Bancroft Gherardi in 1908, the subject of telephone service to the East was discussed at length with municipal officials and business leaders there. Again, Carty's biographer relates that, while in a West Coast city, Carty saw a statue to Seward, Lincoln's Secretary of State, on which was the inscription "To a United Country"—which evoked the remark that such a thing could not be considered a reality until the country was united by telephone. There are many such incidents in telephone history reflecting the idea of *universal service* which marked the leadership of Theodore N. Vail, who was President of the American Telephone and Telegraph Company.

So we know that the hope, the aim, the expectation of talking from coast to coast had been crystallizing even before telephone wires crossed the Mississippi. But when President Vail reached the decision that a transcontinental line should be built, there was little to indicate that, on the basis of immediate demands for transcontinental service, the undertaking would justify itself economically; or, for that matter, that in the existing state of the telephone art it could be carried through successfully. It was typical of his leadership that if a project was needed, its immediate practicality did not interest him;

it would prove its value—and it invariably did.

So, among the raw materials for this undertaking of closing the gap across the western section of the country was a great deal of faith; for at the time of Vail's decision, the vacuum tube repeater that was eventually used—and the only type of amplifier which made coast-to-coast telephony possible on a satisfactory basis—had not even emerged from the laboratory.

The Problems Were Many, Varied, and Great

THERE was something else that would make this last jump a real hurdle, and a formidable one to negotiate. In all of the previous westward extensions, the line had gone through territory that was developed to some extent. As it pressed onward with the years—to Chicago, to Omaha, to Denver—its every further stride brought to more people a quick and intimate contact with increasing areas of what was, to each newly reached territory, "back East."

But in those days there was little development, except at Salt Lake City, between Denver and the Coast. West of Denver it would be "San Francisco or bust!"

In still another way the problem was quite different from that of digging General Goethals' "Big Ditch." As the editor of a New York paper afterwards expressed it, it was "a struggle and triumph against microcosmic difficulties, a victory over tremendously important trifles, where the Panama Canal had been a titanic battle between the master-machines of man's devising and the might of Nature." The construction itself, building new pole line and stringing new wires, was an arduous task, but it presented no particularly new problems. The real problem was to make the wires talk satisfactorily across the face of a continent.

West of Denver the actual pole-line work consisted mainly in closing gaps in lines already built along the principal way of travel into California. This required the construction of a new pole line from a point just west of Salt Lake City across Utah and Nevada, a stretch of some 475 miles. A 96-mile cut-off was also to be built northwest of Denver, where the existing line made a long detour. In addition, considerable pole replacement work was required to strengthen the existing lines.

It having been decided that the transcontinental line should be ready for commercial service upon the opening of San Francisco's Panama-Pacific Exposition, early in 1915, construction work was begun by the Mountain States and the Pacific Telephone and Telegraph Companies in the Summer of 1913.

ONE of the first questions to settle was raised by the Great Salt Lake. The natural route for the telephone line followed the Western Pacific Railroad, south of the Lake. But there was a serious problem of insulation in this region to solve first. During damp weather, moisture settled on insulators which had become coated with salt dust blown there by the wind. This combination seriously impaired the insulation. Exhaustive tests showed that if the insulators were clean when they were first in-

MEASURING THE SPAN
The surveying party lays out the route in Nevada

stalled, and were thereafter cleaned periodically, they would hold up. In this section, therefore, every insulator was washed carefully with spring water—hauled, sometimes, from a spring sixty miles away. Thereafter, a specially developed mobile "vest pocket" boiler and steam jet were used for routine cleaning.

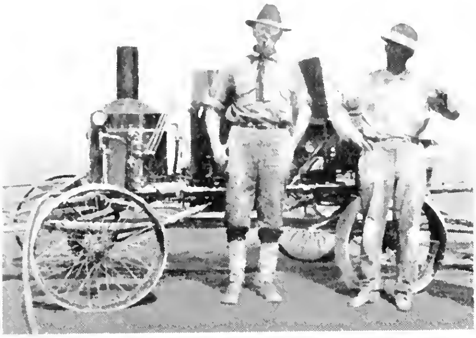
Once it became evident that these measures would be effective against the salt condition, it was decided to follow the shorter route south of the Lake.

It may be interesting to accompany the party that surveyed the route between Denver and the Nevada state line. It consisted of about a dozen men, and traveled usually in wagons drawn by horses or mules, with tents and full equipment, and food and supplies for many days. By arrangement with the railroad, their water was brought to a convenient siding in a tank car, and another car brought food and supplies at regular intervals. Sometimes a couple of box cars replaced tent and wagon as living quarters and means of transportation.

Built by Men of the Mountain States and Pacific Companies

THE procedure of the survey party was for the chief of the party to ride ahead—he was the only one on horseback—and trace out the general course to be followed. Traversing the 7,000-foot plateau north of Denver, the surveyors had no rugged heights to scale or skirt, but the ground was sufficiently irregular to make a survey without topographical maps—not then available—a laborious task.

The principal reference marks in work of this kind were the "cornerstones" marking the corners of mile-square sections into which that region had been divided by government surveyors. But these cornerstones were



TEAKETTLE ON WHEELS

This mobile boiler provided a steam jet for cleaning insulators on poles in the vicinity of Great Salt Lake

not always to be found, so that the task sometimes resembled that of a navigator off-shore.

The navigation was complicated at the outset by a rather unusual phenomenon. In the region north of Denver, the surveyors passed near a mountain in which were deposits having such marked magnetic properties that the compass was of little use, and they were obliged to fix their position from time to time by astronomical observations with their transits.

While the salt and mud flats west of Salt Lake City were no playground, that particular stretch presented no difficulty from the surveyor's point of view. It is on these salt flats that Ab Jenkins, Sir Malcolm Campbell, and others have in recent years hung up such astonishing automobile speed records. Level as a pool table, the expanse of salt and mud offered no topographic problems. It was merely a task of laying down a line of stakes parallel to the Western Pacific roadbed and 1,000 yards north of it, in a bee-line stretching from one horizon to the other for a distance of about 42 miles.

Following upon the heels of the survey party came the line gangs of the Mountain States Company. They traveled like the survey crew, with teams carrying tents and supplies, or in box cars. The foreman was known by the cook he kept, and he generally had a good one. Eating with the construction gang was a rite which many telephone engineers who travelled over the route remember with pleasure.

LIKE the surveyors, the construction men ploughed into some rough weather at the outset, and from the end of October onward, almost everybody was on snow-shoes, and the material was hauled on bobsleds. A foreman working near Leroy, Wyoming, tells of getting "no bottom at twelve" in a gulley, with a pike pole. With this came considerable subzero temperature, and there is a legend that in more than one case the men never knew how cold it really was, because the foreman took the thermometer to bed with him.

Out on the salt and mud flats, these gangs found entirely different conditions, equally arduous. This arid expanse, devoid of vegetation, is the bed of a prehistoric lake. In the winter there is a considerable amount of casual water, blown about the flats by the wind. When the wind is from the north there may be a foot or so of water on the route traversed by the telephone line. During the construction work, this phenomenon produced a certain amount of waterborne commerce, it being frequently necessary to haul materials from the railroad to the line on rafts.

The ground on these flats was mostly mud, and often caved in as the holes were dug; while in other places, when holes were blasted, the dynamite blew the salt away, leaving little to pack the poles with. But somehow rock or other material was found to pack the sides of the holes and give the poles a firm footing.

With the advent of summer, the temperature in this region sometimes went up to 130 degrees. The reflected glare from the sun was blinding, and even the horses wore dark spectacles.

MEANWHILE the men of the Pacific Company were encountering equally arduous and varied conditions in their work across Nevada and through the Sierras.

Over a considerable part of the route to be followed in Nevada there were no roads. As a first step the Company sent out a construction foreman who knew the country, to trace out the best path. Following him, the survey party was guided by the stakes he had driven and by wooden laths placed in prominent places—perhaps with a note with directions to nearby water-holes and other useful information.

After the survey party, the construction gangs had to do a lot of their own road-building—which at times included bridges.

Along this route, water was a frequent problem. Sometimes it was uncomfortably scarce, sometimes overabundant. For instance, there was Humboldt Sink, a lake of uncertain extent west of Lovelock, Nevada. The gang delivering supplies had laid poles, in piles of about twenty, near this body of water, along the line marked by the surveyors. It might be explained that the word sink is the geological term for a "basin in which a river terminates either by evaporation or percolation." Without warning one day, evaporation or percolation ceased abruptly. The water began to rise, and before long the poles were spread over several square miles. It took two men on a raft made of telephone poles several hours to retrieve this valuable flotsam.

When it came to constructing the line through the shallow lakes in this section, none of the post hole machines then on the market would work satisfactorily under the conditions. So one of the telephone men devised a machine like a big auger which did the work perfectly.

UP in the Sierras the gangs stringing wires encountered quite different conditions, with snowfall reported to be the worst in thirty years and temperatures of 40 below. A great part of the supplies was hauled by bobsled, and one of the foremen working in Truckee Pass, where they had seventeen feet of snow, relates that he had to put snowshoes on the horses. In the Spring, this thick mantle of snow turned into floods that swept canyons, changed river beds, and kept the construction men away from their task.

Despite such obstacles, there are many examples of a tremendous enthusiasm pervading everyone having a part in the project. It was soon apparent that it was going to be a race against time, which seemed to increase the eagerness of everyone. We have an instance of this in the record of Foreman Neill Bellingham's gang

HOME ON THE RANGE

This camp, west of Wendover, Nev., is typical of the conditions under which the construction forces lived and the country in which they worked while building the First Transcontinental

at Wadsworth. When they saw what they had to accomplish and how short a time they had for it, they held a council of war. At this it was agreed that success could only be achieved by adhering to a prescribed daily routine. They would roll out at 6, lunch would be on the job, return to camp at 5, and lights out at 9. This was the unalterable daily schedule except that every third Sunday they would stop for a general wash-up.

There was Work to be Done East of Denver Too

Meanwhile, back East the "Long Distance Lines Department" of the A. T. and T. Company had undertaken a formidable job. It will be recalled that at the time this project was begun, New York to Denver represented about the ultimate in long distance telephony. To extend the limits of the voice beyond this distance meant a complete rehabilitation of the line all the way back to New York.

The reason for this was that the "loading" then used was entirely unsuited for use with repeaters—which had to be employed if greater distances were to be spanned. This loading was accomplished by coils at short intervals along the line, their effect being to reduce the transmission loss. Here again, therefore, the telephone engineer had to produce something new:—an improved type of loading coil.

Moreover, the spacing of the older coils was not sufficiently regular for satisfactory repeater operation. So the Long Lines men began the work of replacing loading coils and respacing them throughout the length of the most direct route from New York to Denver. Respacing loading coils necessitated installing a prodigious number of new transpositions, with the attendant cutting and splicing of wires on working circuits. And because no telephone engineer is content to rely upon a single strand of communication when it is practicable to provide

HEAVY GOING

Humboldt Lake, in Nevada, is little more than a swamp, but it made pole-setting an arduous task

a "second string for his bow," similar operations were performed upon a second route between New York and Chicago.

One extremely formidable problem for the telephone engineers was that of cable. At that stage of long distance telephony, even the small amount of cable necessary to carry long distance lines into or through a city had a serious effect upon the travel-weary currents. Fortunately, it had for many years been the practice in building long distance lines to skirt large centers, as a consequence of which these lines went into very little cable; so that, on a percentage basis, the amount of cable in the line ultimately set up for transcontinental service was what the chemist would call "a trace." The first pole of the aerial wire line was located in Journal Square, Jersey City.

It would be interesting to go back in time and look at that first transcontinental line through the eyes of the men who had set it up. There it was: four copper wires stretching for 3400 miles, vulnerable to myriad dangers. Just one tiny imperfection —and all coast-to-coast service might be interrupted! All around these wires were a hundred forces, great and small, ready to drain the current off: gales and floods; or a loose connection or faulty insulation making it a prey to those minute enemies, like King Richard's antic Death that comes at the last, and with a little

STRAIGHT ACROSS

The salt swamps east of Wadsworth, Nev., caused no deviation in the directness of the line

IN NEW YORK ON JANUARY 25, 1915

Seated at the table in the offices of the A. T. & T. Co. are, left to right: John J. Carty, Chief Engineer; George McAneny, President of the New York Board of Aldermen; Union N. Bethell, A. T. & T. Senior Vice President; Alexander Graham Bell; Mayor John Purroy Mitchell of New York; C. E. Yost, President of the Nebraska Telephone Company; and Comptroller William A. Pendergast of New York City. In a glass case before Mr. Bethell is a coil of the wire over which Dr. Bell had transmitted his first sentence—"Mr. Watson, come here. I want you"—and at the inventor's left is a replica of his original telephone, which was wired into the transcontinental circuit and over which he spoke a few words to Mr. Watson in San Francisco

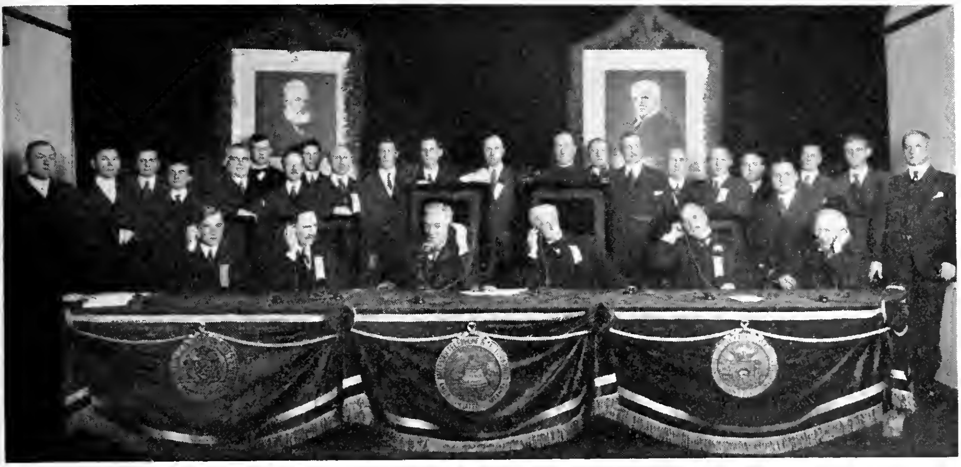
pin "bores through his castle wall, and farewell king!"

That those directing the work were well aware of this is obvious in the provisions they made for patrolling the line previous to important tests and demonstrations. From one coast to another, men were assigned to positions at an average of 14 miles apart, for it must be remembered that the hazards to the line were not confined to the great open stretches of the West and the rocky defiles of the Sierras. The weather in that section can be duplicated on the same scale in the Alleghenies, where snow, sleet, floods, and wind can—and do—mow down a pole line with startling suddenness.

So there was good reason for a solid line of patrols, a regular force totaling around 450 men who, traveling by auto and motorcycle, on horseback or in teams, on foot or on snowshoes, could reach their stations in half an hour—as they did on test mobilizations. An additional 600 men were subject to call.

The Culmination of a Mighty Undertaking

ALL were at their posts, needless to say, or standing by, just a quarter century ago on January 25. Then was at hand the great hour, the dramatic culmination of nearly two years of line construction and of still more years of planning, engineering, lab-



IN SAN FRANCISCO ON THE SAME DAY

In the offices of the Pacific Telephone and Telegraph Company, those seated at the table are, left to right: George E. McFarland, President of the Pacific Company; President C. C. Moore of the Panama-Pacific Exposition; Thomas A. Watson, Dr. Bell's assistant in the experiments which resulted in the invention of the telephone; Thomas B. Doolittle, retired, one of the four incorporators of the A. T. and T. Company; Mayor James Rolph, Jr., of San Francisco; and Chairman Henry T. Scott of the Pacific Company. In the background are officials of the telephone company

oratory research. Then was to be dedicated to public use a telephone line which spanned the continent, made us literally a nation of neighbors, proved beyond doubt the force of that phrase which had till then expressed an aspiration rather than a fact: "universal service."

The importance of the opening of the first transcontinental line to commercial service is attested by the ceremonies which were held on both the East and West Coasts and by the personages who were invited to take part in them.

Seated at a table in the offices of the A. T. and T. Company in New York shortly after 4 P.M. were: Alexander Graham Bell, inventor of the telephone; John J. Carty, Chief Engineer, A. T. & T. Co.; U. N. Bethell, Senior Vice President, A. T. & T. Co.; C. E. Yost, President, Nebraska Telephone Co.; and John Purroy Mitchell, Mayor, W. A. Prendergast, Comptroller, and George McAneny, President of the Board of Aldermen, of New York City.

At a similar table in the offices of the Pacific Telephone and Telegraph Company in San Francisco, the time being somewhat past 1 P.M., were: Thomas A. Watson, who had assisted Bell with his experiments and had manufactured the first telephone under his direction; President G. E. McFarland of the Pacific Telephone and Telegraph Company; H. T. Scott, Chairman of the Board of Directors of the Pacific Company; Thomas B. Doolittle, one of the four incorporators of the A. T. and T. Company, in

1885; James Rolph, Jr., Mayor of San Francisco; and C. C. Moore, President of the Panama-Pacific International Exposition.

Two others, not present in person, were linked by wire with the entire proceedings. Theodore N. Vail, ill, was at Jekyl Island, off the Georgia coast. Woodrow Wilson, President of the United States, was at the White House in Washington.

At half-past four, in New York, Mr. Carty announced that all was in readiness. Dr. Bell lifted the receiver of the telephone before him—and began conversation with Mr. Watson over 3,400 miles of wire. The line was formally in service!

Midway in the conversation with Mr. Watson, Dr. Bell transferred for a moment from the standard desk instrument to a replica of the original telephone which had first transmitted a complete sentence by wire—and which had been specially wired into the circuit for the occasion. Mr. Watson reported that he could still hear clearly over the line. Returning then to the regular transmitter, Dr. Bell concluded a moment later with this stirring tribute:

"All honor to the men who have rendered this great achievement possible. They have brought all the people of the United States within sound of one another's voices, and united them into one great neighborhood."

At this point President Vail, who had been listening although more than a thousand miles from New York, extended his congratulations to Messrs. Bell and Watson. He then exchanged greetings with President McFarland in San Francisco. Mayor Mitchell and Mayor Rolph then conversed, as did others of the guests in the two cities.

A. W. Drake, then Assistant General Superintendent of Plant, now retired, whose recollections have been of material assistance to the authors in preparing this account, makes an interesting commentary on the inventor's reaction to the ceremony. Of course Dr. Bell was tremendously impressed with the realization that this invention of his had developed to such amazing stature in his own life-time. But what seemed to give him an even deeper satisfaction, as is quite understandable that it should, was that intelligible speech could be transmitted 3,400 miles by a replica of that original instrument which he brought into existence nearly forty years before.

At 5:45 in New York it was announced that President Wilson would speak with Mr. Moore, President of the Panama-Pacific Exposition. To the latter Mr. Wilson extended his congratulations upon the prospects for a successful exposition. Mr. Moore responded with assurances that a most cordial welcome awaited the President in San Francisco.

To Messrs. Watson and Bell in turn President Wilson then said:

"I consider it a great honor to be able to express my admiration for the inventive genius and scientific knowledge that has made this possible, and my pride that this vital cord should have been stretched across America as a new symbol of our unity and our enterprise. . . . May I not congratulate you very warmly on this notable consummation of your long labors and remarkable achievements? You are justified in feeling a great pride in what has been done. This is a memorable day, and I convey to you my warm congratulations."

And to Mr. Vail the President said: "Before I give up the telephone, I want to extend my congratulations to you on the consummation of this remarkable work."

At eight o'clock (Eastern time) the lines were opened between San Francisco and Boston, and telephone and civic officials there conversed with the group in the city on the western seaboard.

Demonstrating the Service to the Nation

The official opening was but the prelude to a series of demonstrations that continued for over a year. They linked San Francisco with a score of her eastern neighbors; they introduced to listeners at dinners and meetings a galaxy of famous people: ex-President Taft, General Wood, Admiral Peary, Thomas Edison, and many others. Caruso's voice crossed the continent. Stripped of most of its overtones but still silky gold, it captivated a San Francisco audience—and gave the men at the Salt Lake City testboard something to tell their grandchildren. At intervals during the hour before the show, he would sing a few bars or part of an aria for the men at Salt Lake. "How do I sound?" he would inquire anxiously.

An Indian chief spoke from Winnemucca, Nevada. Two Chinese, in Boston and San Francisco respectively, exchanged greetings, thereby proving that the line was just as good as the one in Dr. Bell's first shop in Boston, where two Japanese had demonstrated that the new device could transmit a foreign language.

There were numerous other "sound effects" featured in these demonstrations. Perhaps the most impressive was the tones of Philadelphia's famous Liberty Bell, transmitted to San Francisco on the day the service was extended to the venerable city that surrounds Independence Square. It broke a silence of eighty years, the bell having cracked while tolling the death of Chief Justice Marshall in 1835.

The two most popular were the sound of surf, and phonograph records. Listeners in San Francisco would be taken by telephone to Rockaway Beach, near New York, to hear the Atlantic Ocean, while the audience in the eastern city would hear the waves roar against the rocks at the foot of the Golden Gate's Cliff House.

The phonograph records were an indispensable property in these demonstrations. It was the hey-day of Sousa and his marches, and day after day, the "Stars and Stripes Forever" and other martial airs vibrated across the continent. Although the technicians who monitored those demonstrations at the repeater stations may not have heard "Stars and Stripes Forever" in all the twenty-five intervening years, it is probable that they could whistle it today with not a grace note out of place.

The demonstrations were a re-creation on a national scale of similar work by which Bell and Watson, in the 'seventies and early 'eighties, had made the East conscious of the new instrument that was among them.

Behind it all was the skillful showmanship of John J. Carty, which was nowhere better illustrated than in the "roll-call" with which each demonstration began and ended. As the master of ceremonies called the final roll of the cities along the route, the testboardman assigned to the demonstration circuit at each station signed off with a "Goodnight, San Francisco"—or Salt Lake, Denver, Omaha and so across the country, until that last goodnight from the testboardman at the city where the demonstration was held. It was a feature long remembered by those present at these demonstrations; it was always effective. Indeed, one master of ceremonies stated in his report that at this juncture he had "seen eyes brimming with tears."

THERE were many similar demonstrations in other parts of the country, before service clubs, chambers of commerce, and organizations of every description.

The demonstrations in the Middle West had an interesting character, and noteworthy results. They were under the direction of T. G. Miller, now Vice President in charge of the Long Lines Department, who was at the time Division Plant Superintendent at Chicago, and they covered an area from Ohio to Nebraska. They were a close parallel to those early lectures of Bell and Watson, for the "show" traveled from town to town in an endless succession of "one night stands" for a period of more than a year. These demonstrations frequently employed several hundred receivers, and according to J. J. Pilliod, now Engineer of Long Lines, who was the engineer on location, they were often wired up for an evening's presentation with a celerity that matched the work of experienced stage-hands.

All these demonstrations were a truly remarkable testimony to the thoroughness of those who had engineered and built this line, and to the alertness of those charged with operating the equipment. In a total of more than 1500 demonstrations the failures were almost negligible. Take the daily shows at the Panama-Pacific Exposition, which began when the Fair was opened and continued well into 1916: the record shows that 1,177 programs were put on; five a day except on Sundays. Only nine shows were cancelled on account of line trouble, and 35 demonstrations were given from Denver instead of New York because of trouble east of Denver. An equally creditable showing was made on the other demonstrations. And there can be no doubt that this fact made a profound impression upon the public mind as to the dependability of this new system and of long distance service in general.

While these spectacular and convincing demonstrations of the first transcontinental line's capabilities were continued for many months, the line was made available for public use within a few hours after the conclusion of the dedicatory ceremonies: at 12:01 A.M. on January 26 in New York—which was, of course, 9:01 P.M. on January 25 in San Francisco; and several commercial calls between the Atlantic and Pacific coasts were handled during the next 24 hours.

Service was Limited at First by Several Factors

THE early service over the First Transcontinental was decidedly limited, however. Under the rules followed by the Long Lines traffic department in the early stages, the only calls that were accepted unconditionally were between New York, Boston, or Washington, and San Francisco. For the purpose of passing upon the feasibility of transcontinental calls to other points, a bureau was established at the New York long distance office, the eastern terminus of the line. Here the transmission problem was canvassed and a verdict rendered.

There were good reasons for this selectivity in accepting calls. The frequency band transmitted was narrow by comparison with that of a modern circuit, producing a voice effect that resembled the early phonograph records. There were wide fluctuations in the efficiency of the circuit with changes in the weather—and there was always lots of weather at one place or another along this 3,400 miles of line. And there was a very definite limit to the volume that could be produced at the end of the line, for increase in amplification beyond a certain point caused repeaters to howl.

IN addition to these technical matters, there was always to be considered the operating procedure, which called for "switches." At the beginning, the number of coast-to-coast calls did not warrant a direct circuit, so that a call from New York to San Francisco was completed by putting together a series of separate circuits. The switches on the First Transcontinental were at Chicago, Denver, and Salt Lake City. There were thus four separate pieces of the line to be put together; and if the call involved some other point beyond New York or San Francisco, there were five. This meant, of course, that before the call could be completed there must be at least one idle circuit in each of the segments. Under these conditions, delays in completing calls were inevitable.

In the early stages of transcontinental service there was an average of about two calls a day. But it was foreseen that this tiny stream would expand to large proportions, to carry the flow of business and social intercourse between the two sides of the continent.

Service and the Demand for It Grew Together

IN the early 1920's, traffic between the East and Southern California was developing rapidly; by that time, something like half of the calls over the cross-country line involved points in the latter region. Meanwhile, technical developments had been proceeding apace. Repeaters, filters, and networks of new design were made available and these, more frequently spaced, permitted removal of the open wire loading. The non-loaded wires—capable of transmitting a wider frequency band and having smoother impedance characteristics and a higher speed of propagation than loaded wires—in conjunction with the new equipment provided circuits noticeably better in quality and stability of performance. Transcontinental service was now ready to expand beyond its early limitations. Engineers already saw not one but four routes between East and West.

The next step was the establishment in 1923 of a second route from Denver to California, extending south through El Paso. Crossing the barren lava beds and mesas of New Mexico and the bleak region of southern Arizona, where the shifting sands sometimes build up to within a foot or two of the wires, this route traverses the Salton Sea section, some 200 feet below sea level, and so to Los Angeles. The use here of carrier current telegraph systems provided needed additional telegraph facilities.

Two years later another important link was forged on this route, when wires were strung eastward from El Paso to Dallas. This, with existing lines through Little Rock and Joplin, established another route to the coast from Chicago, known as the Southern Transcontinental route. Other extensions in the South eventually completed an excellent trunk route across the entire southern part of the country.

A major improvement in coast-to-coast service came in 1926 with the placing in operation of carrier telephone channels between Chicago and Sacramento over the Central Transcontinental route, making it possible to set up three additional talking circuits of high quality over a single pair of wires.

By this time, the development of the Northwest made it desirable to provide a route across the northern part of the country to Seattle. Here it was necessary to reconstruct a great part of the existing lines and to string new wire over much of the 1800 miles from Minneapolis to Seattle. Most of this work had to be done in the summer months on account of the long and rigorous winters and the rugged mountainous terrain of that region. Along this route carrier telephone systems were also installed. This line, known as the Northern Transcontinental route, was placed in service in 1927.

BEFORE passing on to the fourth and newest link between the two coasts, we might look over the eastern section of the country and observe the changes that had been taking place there. Chief of these was the improvement and extension of cable facilities. By 1927, cable facilities were available as far west as Chicago and St. Louis which were suitable for transcontinental business. Gradually spreading over the eastern part of the continent, these cables provided a virtually storm-proof network along the trunk routes. Coming down to the present time, it is significant that in today's transcontinental calls, about 45 per cent of the mileage is in cable, whereas in the original circuits, cable was used for less than one-half of one per cent of the distance.

One more telephone span has been thrown across the country: the Fourth Transcontinental, completed in 1937. This line runs westward from Oklahoma City through Amarillo and Albuquerque, joining a cable in California which carries wires into Los Angeles. The outstanding feature of this line is that it provides for the use of a new and improved type of twelve-channel carrier current telephone system, using frequencies up to 140,000 cycles. This new equipment, together with the three-channel carrier equipment previously available, makes it possible to handle simultaneously over a single pair of wires a total of sixteen individual telephone conversations.

The Developments of a Quarter of a Century

A few statistics on these wire spans across the country will form an interesting contrast with the tenuous link first provided in 1915. There are now about 170 circuits across the western states, available for transcontinental telephone service. Approximately three-fourths of these are carrier current channels, providing voice-ways of excellent quality. Thousands of vacuum tubes insure adequate amplification. Direct circuits from coast to coast give a speed of service that normally averages less than two minutes from the time the long distance operator answers until the start of conversation. (This compares with a delay of about an hour in the early years.) Recognition of these improvements is seen in the fact that during the period of transcontinental construction, traffic between the Pacific Coast and the rest of the country grew twice as fast as the total Long Lines traffic. And there is one more statistic that has had a not unimportant part in this trend: When the New Yorker put in a call to San Francisco in 1915 it cost him $20.70 to talk for three minutes. Today the day station-to-station rate for the same call is $6.50, while the night and Sunday rate is but $4.25.

Speed of service, ease and clarity of transmission, reductions in rates, multiplication of circuits—all these improvements have been brought about in the past 25 years. To them the public has responded with an appreciation of the greater value of the service which has manifested itself in ever-increasing use. Whereas the average over the new line during its first year of operation was two calls a day, now on the average about 1,700 calls a day flash back and forth between the Pacific coast and points east of Denver.

This account of the building of the first transcontinental line, and of the extensions of the service in the years since, has necessarily been primarily a story of physical growth. It would be incomplete, none the less, without some mention of the social implications of this tremendous web of wires spreading out over mountain and forest and desert, linking tiny hamlets and great cities. Over it go telephone conversations, the radio programs of the broadcasting networks, the telegraph and teletypewriter messages of business, government, and the press, and even pictures of events happening a thousand or three thousand miles away but a few moments or hours before, in a never-ending flow. More than a thing of wire and poles and repeaters and supplementary apparatus of all sorts is this transcontinental network: it is a communication system, nation-wide and nation-serving, of a completeness, flexibility, and dependability not to be matched throughout the world.

III. TRANSCONTINENTAL PANORAMA*

From the Solution of the Specific Problems of Transcontinental Telephony Have Come Changes and Advances in the Art Which Have Affected Every Aspect of the Service

By FRANK B. JEWETT

As a topic this evening I have chosen the epoch of transcontinental telephony, because it was twenty-five years ago last July that the first transcontinental circuit carried its first conversation, and it will be twenty-five years ago next January that the first transcontinental line, which consisted of three circuits, was opened for public use.

My choice, however, is based upon much more than a mere desire to commemorate a now far-off event, propitious though such a gesture may be. I hope that in the course of my remarks I can portray this early telephone line for what it was in fact: the progenitor of much that has taken place in the last twenty-five years in a very active sector of electrical engineering. It marked the dawn of a new era in electrical communication.

As we review the history of this period, we shall witness new physical appliances recasting not only the technological side of a business but its traffic and commercial aspects as well. I hope to make clear to you the interplay of technological and economic factors over a considerable period of time to the end that copper and iron in huge quantities have been replaced by minute electron streams in vacuo; and, further, that the attenuation of telephone currents, once the quintessence of the telephone engineer's troubles, can now be pushed to levels hundreds of times higher than the early limit before it becomes comparable with the other economic factors involved.

In any general survey of the changes and improvements which have altered the art of telephony during a period of time or have flowed from the successful solution of a specific problem, one must always have in mind the ultimate objective of commercial telephony. This objective is simply stated; the attainment of it even approximately is a long, hard road. From the day when men of vision realized the potential possibilities of Bell's invention, the ultimate technical objective has been a service at once so extensive and adequate that any one, anywhere, at any time, and on demand, could talk to any one, anywhere else, with ease and clarity.

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* The Steinmetz Memorial Lecture, delivered before the Schenectady Section of the A. I. E. E. on November 2, 1939.

Added to this has always been, of course, the economic and social objective of a cost so low as to offer no substantial bar to an essentially untrammeled use of telephony by any one who has occasion to talk with another at a distance.

For the Bell System as a public service agency, all this is succinctly stated in the frequently quoted objective of the best possible service at the lowest possible cost consistent with financial stability and fair treatment of employees. When, however, one attempts to translate this broad objective into the concrete technical terms needed for its fulfillment, the phraseology is quite different.

For the research man and the engineer, the goal is one compounded of a transmission art so perfect that distance *per se* is no barrier; that telephone circuits and all that they require in auxiliary apparatus for proper operation can be produced so cheaply as to be available in the profligate numbers required for a universal no-delay service; and, finally, that the vast society of Lilliputian currents must live amicably with each other tightly packed together in a world of Brobdingnagian interference.

It is a distant goal even when viewed through the glasses of perfection which picture direct circuits for every desired connection. It is doubly distant when his practical senses tell the scientist and engineer that they must attain part of the solution with indirect switched circuits and, further, that these switches must neither delay the service nor affect its quality appreciably.

The goal of perfection is still ahead, but we have made astounding progress toward it in the quarter century since the first voice spanned the continent. In very large measure this progress is directly the result of developing fully the latent possibilities of the physical instrumentalities unearthed in the search for an answer to transcontinental telephony. There may seem to be little connection between the quest for an amplifying device to solve a specific transmission problem in 1914 and an engineering study in 1939 to work out a nation-wide traffic routing system, and yet one is the direct lineal descendant of the other.

A Structure No One Has Ever Seen Entire

IN considering the evolution of telephony, I must remind you that we are dealing with a structure that does not lend itself to pictorial representation. I wish this were not the case. I wish that it were possible to throw on the screen here a lantern slide that would depict a transcontinental line and upon which I could, by appeal to your eye, assist you in visualizing the additions and changes which mark the progress of a quarter of a century. When one attempts by word of mouth to explain the problems of telephony and how they have been and are being overcome, he has, I must admit, a uniquely difficult piece of work in hand. He must reduce to words—and I know that you would prefer not too many words—a structure which not even he himself—let alone any one in his audience—has ever seen in its entirety. Likewise, he must put into words as best he can a host of concepts which find their proper expression only in mathemati-

THE NORTHERN ROUTE

The most northerly of the transcontinental lines crosses the Continental Divide a McDonald Pass, west of Helena, Mont. This view is to the East from just below the summit

cal symbols and processes or in the specialized language of the physicist.

If I could transport you rapidly, magic-carpet-wise, out across the continent three thousand miles or so, thus enabling you to visualize what a complex thing is this creation we are to consider this evening, I might hope to convey to you at least a superficial conception of its elaborateness and seeming fragility. Only in this way, I am sure, would you fully sense how remarkable it is that this far-flung and delicate structure should be endowed with surprising electrical stability and immunity to meteorological and man-made interference.

LET us at the outset imagine a single pair of wires extending out of the window and thence across-country for hundreds or even thousands of miles; and let us bear in mind that these wires, by virtue of their length, have become possessed of considerable amounts of distributed capacity, inductance and leakage—and are, in addition, subject to a variety of induction effects from paralleling communication and power circuits.

Moreover, in many instances one or both pairs of wire are packed tightly together with many similar pairs and enveloped in an impervious lead sheath to form a cable in which a neutral gas, such as nitrogen, is maintained under pressure, and which, should a leak in the sheath develop, operates an alarm circuit to sound a distant SOS. We must also note the presence, on many of the pairs, of loading coils spaced at regular intervals varying from about five-eighths of a mile to one and one-eighth miles, depending on the type of cable.

Each loading coil is a winding of wire on a special magnetic core. Its function is to assist the speech currents, as they travel, to overcome the large attenuating effect of the electrostatic capacity of the tightly packed wires. These coils, of which there may be as many as two or three thousand called into play in the handling of a single message, must be electrically identical to a very high degree.

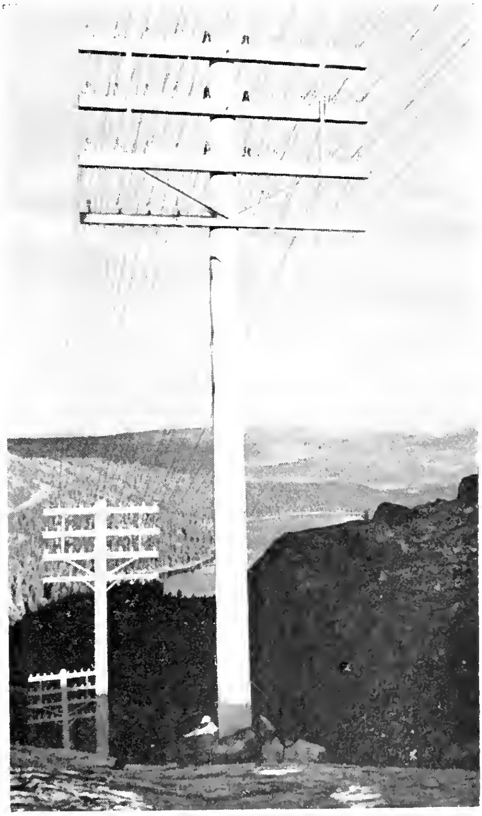
Next, there is the repeated and uniform twisting of each pair of wires at its own particular pitch to secure such nicety of balance, both electrostatic and electromagnetic, that not more than a millionth of the power of a telephone circuit will pass over inductively to any neighboring circuit.

Then at intervals of fifty miles for certain types of cables, and at shorter intervals—even as low as five miles on certain newly projected types—we would encounter the thermionic amplifiers which restore the message energy after attenuation by resistance and other forms of dissipation. Closely associated with certain of these amplifiers are other devices which suppress electric echoes or which automatically counteract the effect of changes in conductor resistance induced by changes in temperature.

So much for our imaginary flight! Many of the features of a long telephone line which I have just enumerated are comparatively recent accomplishments; they project me somewhat ahead of my story. We must return to the year 1914, when a long distance telephone line consisted of a pair of large copper wires strung in the open and with magnetic loading coils spaced along it at intervals of eight miles.

The Need for an Amplifier Was Fundamental

THE day of speech current amplifiers had not arrived, except for a carbon microphone type which, because of distortion, was applicable only as a single stage amplifier on non-loaded lines. Every long circuit operated essentially upon the basis that no energy came out at the receiving end which was not introduced at the sending end—and, needless to say, very little of that. It was also neces-



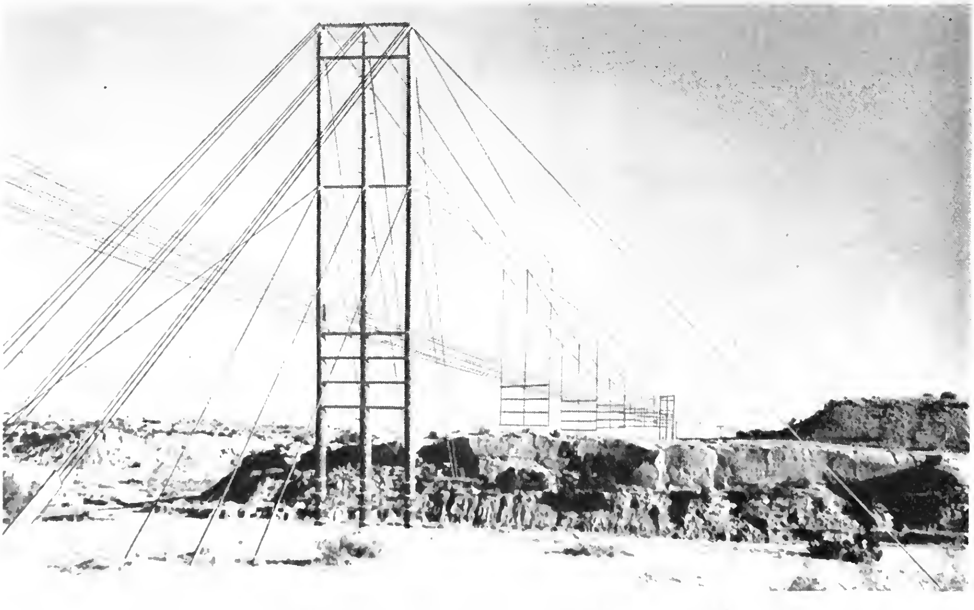
THE "CENTRAL TRANSCONTINENTAL"

The line is shown here at Donner Summit, Cal., with Donner Lake in the central background sary to preserve enough of the energy of the various frequencies represented in speech so that intelligibility was not sacrificed: a requirement which added appreciably to the problem.

With the use of 8-gauge hard drawn copper line wires (weighing 870 pounds to the loop mile) augmented by loading, it was just possible to carry on a conversation between New York and Denver. How slight the margin of safety was in that line is well illustrated by the fact that it had an equivalent of about 35 decibels, so that the power at the receiver amounted to only about 1/4,000 of the power sent out by the transmitter. On this same basis a telephone line spanning the continent would have yielded only 1/100 as much power at San Francisco as at Denver; i.e., about 1/400,000 of the power.

A comparison of these two figures shows at once that there was no hope of solving the problem of transcontinental telephony by some scheme which would apply to the circuit a larger power than the typical telephone transmitter. Any feasible solution must necessarily involve some sort of current rejuvenation at several points intermediate between transmitter and receiver, since the use of heavier copper was economically unsound: in other words, tandem amplification, with all its obvious difficulties, was the only way out.

THE search for a successful amplifier or repeater extended over years, and almost simultaneously three promising devices were brought to the point of trial: one, an improvement of that already mentioned, was a me-



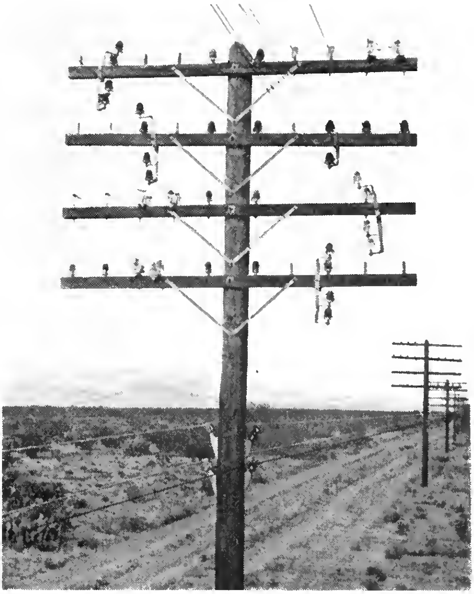
"LARGO NO. 1" ON THE FOURTH TRANSCONTINENTAL LINE

This photograph has been retouched to show the catenary suspension of the wires over this "dry wash," which is well but not favorably known to telephone men in the territory. It lies west of Tucumcari, N. M.

chanical structure which used the amplifying property of the carbon microphone; one a low pressure arc which possessed a negative resistance characteristic; and, finally, one which employed an electronic current controlled electrostatically by a grid of metal wires placed athwart it. I need not add that this third arrangement was derived from the audion of Lee DeForest, which he was then using to receive radio signals. That was more than a quarter of a century ago, when the science of thermionics was in its infancy.

To those of us who were concerned with the problem of the telephone repeater at that time, it was far from evident which of the three alternatives would ultimately win in the struggle for existence. Engineering, I need scarcely remind you, is full of questions of merit quite like the one presented by the repeater, and the answer is seldom to be got except on the basis of experience. Naturally, our recourse was to practical tests. The equivalent of a transcontinental circuit was arranged in such a way that each of the three types of repeaters could be switched in and out readily, and extended trials were instituted.

IN this case the answer was not long in revealing itself. The behavior of electronic vacuum tubes designed especially as telephone amplifiers left no doubt that it was at once satisfying in its then performance and full of promise as to additional applications in the future. As we look back upon that situation in the light of our present knowledge, perhaps our wonder is that so recently the ubiquitousness of the vacuum tube should have lain unrevealed.



THE "SOUTHERN TC"

Here the line is crossing arid, cactus-covered plains west of Tucson, Ariz.

We must, however, bear in mind that it employed a high vacuum and that pumps for creating such, even within the physics laboratory, were but lately introduced; moreover, that it also contained a fragile filament—sometimes coated and sometimes metallic—which served as electron emitter and which was subject to little-understood vagaries. The making of vacuum tubes, far from being a factory process, was one which called for the skill and personal supervision of the laboratory; and even after this bestowal of care, the filament might fail in a few hours or a minute leak might destroy the vacuum and thus end the life of a device upon the making of which many anxious hours had been expended and on whose reliability the integrity of service depended.

I realize that these few words will give but a very imperfect picture of the task confronting those who undertook to adapt DeForest's audion to the work of the telephone repeater. Unless one has tried with a molecular pump (so-called) and a liquid air and charcoal combination, and aided by baking and bombardment, to drive a seemingly endless amount of gas out of glass walls and metal plates and grids of a tube, and yet leave the activity of the filament coating unimpaired, he can scarcely realize the hurdle which the telephone engineers of nearly thirty years ago had undertaken to clear. And suppose an experimental line were to prove workable, what chance would there be, considering the highly personalized production techniques and the final fragile character of the vacuum tube as then constructed, that the line could ever be more than an unreliable appendage to a network of shorter circuits?

Before an audience which is as familiar with sturdy vacuum tubes as it is with incandescent lamp bulbs, it becomes impossible to recount twenty-five years' progress step by step with the intention of finally revealing the present status in climactic fashion. You think little more of multi-electrode tubes than you do of bolts and nuts, and complex modulator and control circuits are as much the order of the present day as dry cells and magnetos were a generation ago. I shall, therefore, not attempt any dramatic effect. Instead, my objective will be, by dealing in engineering values, to bring out the interplay of the more significant factors, tracing the line of development and argument which has completely remade the technique and the instrumentalities of long distance telephony.

Before closing this reference to the history of the vacuum tube itself, I should like to say, however, that the telephone engineers were not alone in realizing its potential usefulness, and I know it will come as no surprise to most of you that very important contributions were made at the research laboratory of the General Electric Company here in Schenectady. As a matter of fact, a nip-and-tuck race was run between the engineers at the Bell Telephone Laboratories in New York City and those in the General Electric Laboratory here. I cannot refrain from smiling as I look back upon those days. It seems to me that each group was making such rapid progress that they naturally felt after each new success that at last they must necessarily have out-distanced their rival—and were a bit disturbed to discover, in due course, that the adversary was still abreast.

What the Amplifier Has Done for Wire Economy

As I have already hinted, the advent of the vacuum tube amplifier radically changed the point of view of the engineer regarding long distance telephone lines. Over a period of years he switched from a policy of extreme parsimony to one almost of prodigality. Where initially his every thought had been to design his lines so as to minimize the possibility of energy loss at every point, he later chose smaller and smaller line wires

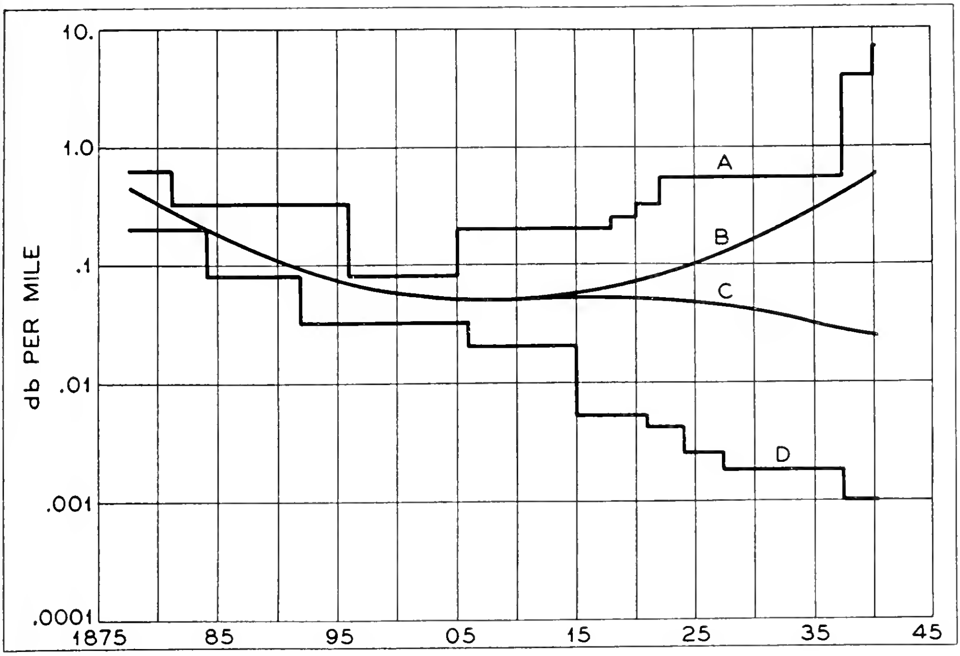


FIGURE 1

Curve A represents long distance circuits possessing the highest attenuation per mile. The extreme for 1940 represents the coaxial cable now being installed. Curve D represents circuits possessing the lowest attenuation per mile after repeaters have been taken into account. Curve B represents the average of all long distance circuits without repeaters, and Curve C represents the average with repeaters

deliberately because the saving on copper more than compensated for the additional amplification entailed. Figure 1 will be of interest in this connection. On it (plotted to a logarithmic scale) the ordinates represent loss per mile of circuit.

Let us consider curve B first; it shows the average loss per mile of long distance telephone circuits as it has varied over the years. You will note that during the period from 1880 to 1915 the average loss per mile fell, the reason being that heavier and heavier copper was resorted to. Then, in 1915, with the advent of repeaters, the circuit attenuation begins to mount, since lighter copper and higher frequencies could be employed. On the other hand, you will note that curve C, which represents the over-all loss including repeaters, still continues to decline. Curves A and D represent the extremes of loss in individual types of circuit.

Prior to the repeater, the loading coil was of paramount importance as a conserver of the power of the telephone currents. As so frequently happens in engineering design, this economy was not always to be obtained without paying a toll. For instance, in the first transcontinental line loading had to be pushed to such

TABLE 1

VOICE FREQUENCY REPEATERS INSTALLED IN BELL SYSTEM

Year	*Total* *
1908	16
1910	41
1915	136
1920	1,250
1925	7,500
1930	80,000
1935	102,000
1938	107,000

* As of December 31

a point that a serious degradation of speech quality resulted. The more heavily loaded a telephone line—that is, the larger the inductance of the loading coils associated with it—the narrower becomes the band of frequencies which the line can transmit. It was the discovery of this effect of loading that led a few years later to the invention of the electric wave filter. It happens that the discovery was made mathematically by Dr. George A. Campbell—who has but recently retired from the Bell Telephone Laboratories' staff. He it was who saw the possibility of simulating and generalizing the effect of a long telephone line, by lumped inductances, capacities, etc., to the end that very compact electric wave filter circuits could be constructed. A little later I shall have more to say regarding the present-day uses of these filters.

Returning to the first experimental transcontinental line of 1914, it included three repeater units, placed at Pittsburgh, Chicago, and Denver, respectively. These, when supplemented by very heavy loading, were just sufficient to make the circuit usable. The quality of speech transmitted left much to be desired, however, for the inductance of the loading coils was such that an effective band of speech frequencies only about 900 cycles wide could traverse the line. This is to be contrasted with a band about 2,500 cycles wide which is handled by ordinary circuits today, while those that are employed for interconnecting broadcasting stations may transmit a band three times this latter figure; and even this is but a fraction of the band of carrier frequencies that a multi-channel carrier system will transmit.

THE original transcontinental line with but three repeaters was purely experimental. It proved, however, that the country could be spanned telephonically, and it also established the supremacy of the vacuum tube amplifier as against the arc and the carbon microphone. Shortly after commercial service started in 1915, six repeaters were substituted for the original three, and these were, of course, spaced about as uniformly as the location of cities and towns would permit. The line itself had a loss of about 60 decibels and the repeaters gave a gain of about 40 decibels. Of course, the day of unattended repeaters and automatic gain control was still undreamed of. Even with six repeaters it was necessary to retain heavy loading, so that the original line represented about the allowable minimum in speech quality.

But the vacuum tube quickly revealed itself to be a fertile subject for research. Over a period of a few years, more efficient and much longer life filaments were discovered, and improved assembly methods were devised as well as rapid methods of evacuation. Thus it became possible, step by step, to be more generous in the use of repeaters in the long distance telephone plant. Table 1 traces history from this standpoint. With success accumulating behind us, particularly by way of improved repeaters and enhanced knowledge of how to operate many repeaters in tandem, it was not long before we overhauled the original transcontinental line, removing the loading coils altogether. Thus, the one device which a few years before symbolized long distance telephony had now begun to slip.

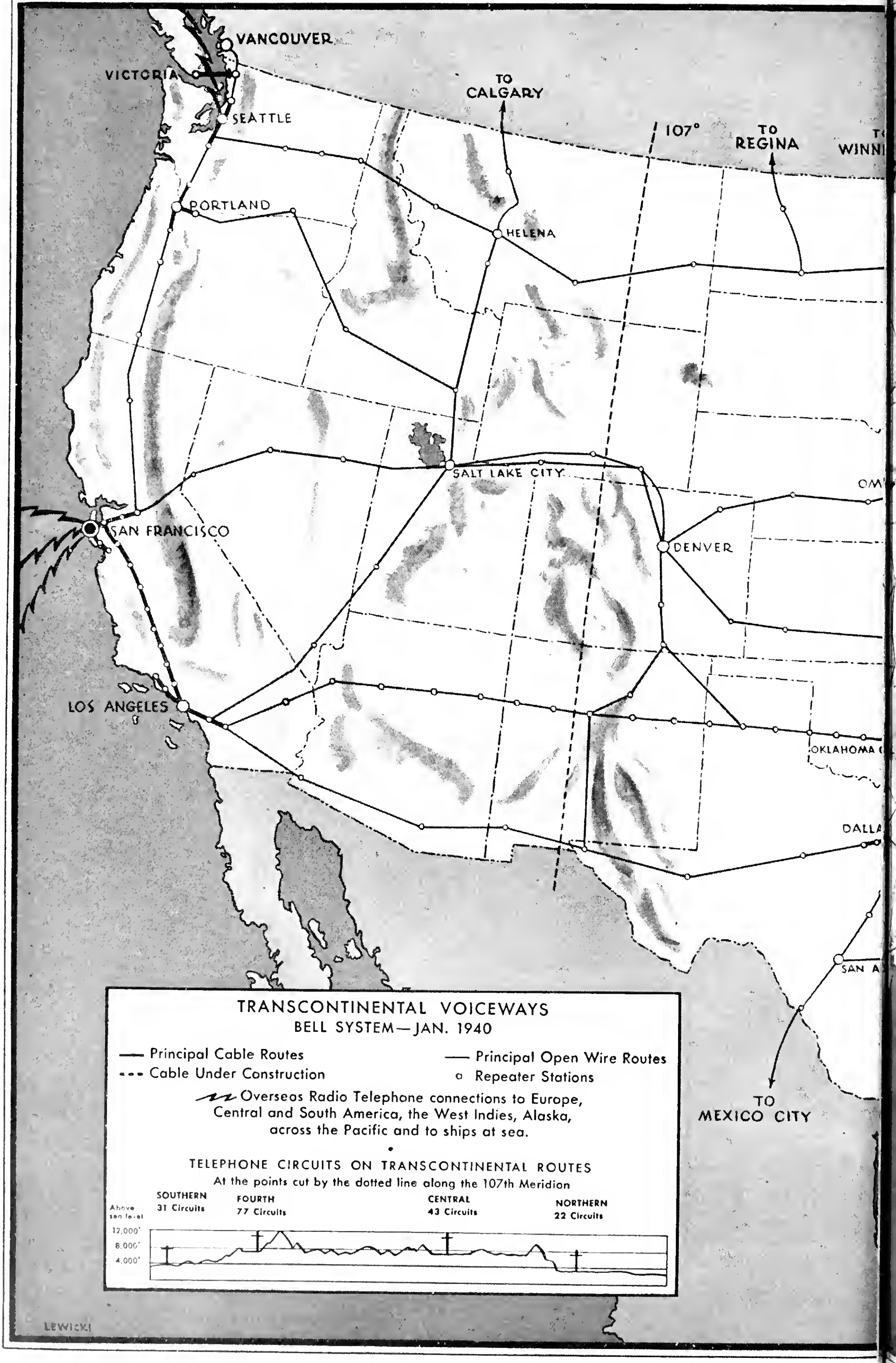
Coil removal from the transcontinental line was dictated by a desire both to improve speech quality and to obtain more circuits. The *demand* for service was increasing in response to *improved* service, and removal of the loading introduced the possibility of multiplexing the lines with carrier systems, so where we had originally possessed only three circuits we could now operate about nine.

At the same time, of course, repeaters were becoming more and more the order of the day on circuits of intermediate length. You will have gathered this from Table 1. In fact, the importance of the repeater is in considerable part due to the changes it has been instrumental in working in the entire toll plant, short haul circuits as well as long haul. As illustrating this and also illustrating the degree to which it has enabled telephone engineers to plan their circuits on a basis other than the early one of conserving the ingoing transmitter energy, I should like to mention a toll project employing cable with small gauge conductors which dates from about 1920; that is, five years after the initial transcontinental success.

Repeaters and Cables

IN a cable, due to the fact that the wires of each pair are close together and therefore display large electrostatic capacity compared to an open-wire pair, the attenuation is great unless very heavy conductors are employed. Even then the distortion in non-loaded cables is great, and so for many years prior to the repeater cable was anathema in toll circuits. In other words, so long as the initial ingoing energy was all that could be invoked for reproduction of the message at the receiver, cable was generally rejected.

Nevertheless, cable possesses other virtues so obvious that the toll engineer always eyed it with the deepest envy. Circuits in cable are inherently stable because they are protected from atmospheric moisture. They are also less liable to breakage and to inductive disturbances from paralleling circuits, notably power lines. However, the full virtue of a cable is not realized until the density of traffic becomes large enough to require a large group of circuits. A full-sized toll cable, for instance, may contain as many as 300 or 400 separate lines, and as a normal daily message capacity of a single circuit is perhaps thirty to forty, the potential capacity of such a cable is very considerable. It developed, however—and perhaps it was one of those fortunate coincidences—that by the time a cable became feasible from the technical point of view, the demand in the regions of



THE HEAVY LINES IN THIS DEPICTION OF THE BELL SYSTEM'S T
TO AS *FIGURE 2* IN

NINENTAL CIRCUITS REPRESENT THE CABLE NETWORK REFERRED
MPANYING ARTICLE

denser population had risen to a height to justify it economically.

OMITTING reference to an early heavy wire cable between Boston and Washington, which was operated without repeaters and which was installed because it was deemed important to have unfailing telephone service along this portion of the Atlantic seaboard, the first repeatered cable (and it was therefore one employing relatively small gauges of wire) was placed between New York and Pittsburgh, with the plan of extending it as need arose to Chicago and perhaps to points farther west. The New York–Pittsburgh section was engineered in 1920 and went into service in 1922, seven years after the transcontinental trial had affirmed the value of the repeater. Today, so rapidly has the demand for long distance telephony grown, that we have not simply a spur of toll cable, but a system which may, without exaggeration, be referred to as a network. As you will see from Figure 2 (pages 48–49), it runs from Maine to Georgia and Texas, and as far west as Omaha and Dallas, and interconnects the important cities of the eastern half of the country.

Twenty-five Years of Progress Against Attenuation

IT might be interesting to digress for a moment at this point, so that we can see how far we have progressed over a period of twenty-five years in the attack upon attenuation. You will recall my having mentioned that the original transcontinental line had an attenuation of 60 decibels, of which about 40 decibels were neutralized by six repeaters. Large line wires and loading coils were employed to minimize to the limit the part to be played by the amplifying elements in the circuits. How vastly different the situation is today will be apparent when I tell you that the attenuation of a cable circuit connecting New York and Pittsburgh is 200 decibels, while for one connecting Boston and Dallas it is 1,100 decibels.

Lest you are not all familiar with the decibel as a unit of attenuation, I will say that to write these results in the form of fractions gives, for the first, 10^{-20}, and for the second 10^{-110}. In other words, a telephone message in traveling from Boston to Dallas must receive a 10^{110}-fold amplication in order that it may be compensated against the incursions of attenuation. If this enormous amplification had all to be applied at the sending end of the circuit, there probably wouldn't be enough energy in all the coal reserves of the earth to do the trick. Success lies in doing a little bit at a time, for between Boston and Dallas there are some 45 repeater points (the precise number depending upon the routing) and the average gain of a single repeater is about 23 decibels, or about 200-fold on an energy basis.

I MIGHT as well disclose to you at once, however, that such figures as I have just cited are mere child's play nowadays. There is adequate justification in numerous instances for undertaking the multiplexing of cable circuits by the carrier principle. Not only does such an arrangement effect further economies in copper and lead, but what is perhaps more important, the transmission of the high frequencies of carrier systems involves the removal of all loading coils. This, to be sure, causes the attenuation to mount, but a compensating gain appears in reduced time of transmission.

Loaded cable circuits possess a relatively slow speed of propagation—perhaps 10,000 to 20,000 miles per second—with the result that, for the longer circuits, the echo which returns to the speaker from the far end of the cable lags sufficiently in time to be extremely disturbing. To avoid the echo difficulty, the longer loaded cable circuits are equipped with so-called echo suppressors, which operate to permit propagation in only one direction at a time, and are controlled, of course, by the person who first starts talking after any pause. But with non-loaded cable circuits, including all equipment, the speed of propagation jumps to around 100,000 miles per second—more than half the speed of light in free space—with the result that except on extremely long circuits the echo is not separable by the ear from the inducing sound.

BUT what of the attenuation? It seemed high enough on *loaded* cables. It naturally jumps many fold, but not more than the capacity of repeaters to counteract. Circuits are in daily use in which the attenuation is as much as 2400 decibels, and experimental lines have been formed and operated by the looping back and forth of several cable pairs to build up the equivalent of an 8,000-mile straightaway whose total attenuation was about 12,000 decibels. Such a circuit needs a total amplification, on an energy basis, which amounts to 10^{1200}, a ratio so enormous that it quite transcends ratios such as the size of the total universe to the size of the smallest known particle of matter.

Naturally, the problem of balancing this huge amplification against the correspondingly huge loss to the required precision, 1 decibel or 2 decibels, is difficult. Fortunately, a new form of amplifier employing the principle of negative feedback—it is an arrangement with which some of you are doubtless familiar—was invented by Mr. H. S. Black of the Bell Telephone Laboratories, which has enabled us to solve the problem. By using Black's negative feedback we are in possession of amplifiers giving 50 to 60 decibels gain with a variation of not more than .01 decibel with normal battery and tube variations. I might also say that were it not for such a repeater, the coaxial type of cable, which again possesses attenuation of the order we are now considering, would be quite impracticable.

TIME will permit me to do no more than mention in passing the fact that those large amounts of gain must be controlled automatically, particularly in response to temperature changes. Cable circuits, by their nature, show only minor variations in capacity, inductance, and leakage, but the resistance of their conductors can change by large amounts from winter to summer, and even from hour to hour. These changes are, of course, more rapid in the case of overhead cables than in those placed underground. However, in each, automatic regulators which take their cue from so-called pilot wires running through the cable along with the speech pairs are necessary. Thus, the annual variation found upon a cable circuit

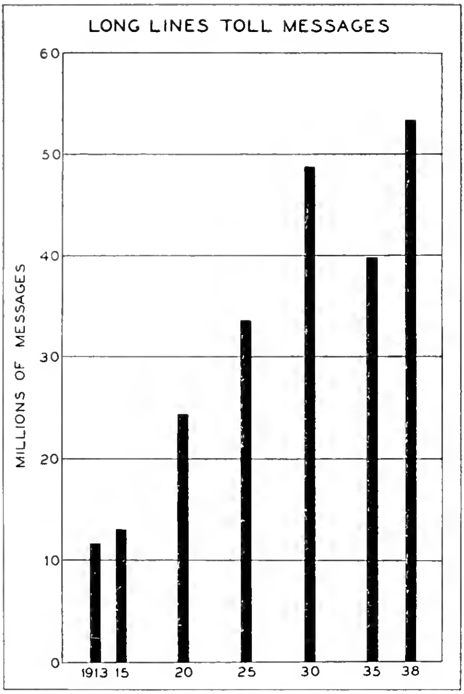


Figure 3

Twenty-five years of long distance toll traffic

may be as much as 100 decibels, or more than the entire attenuation of the first transcontinental line. In fact, the variation experienced on some of the long carrier channels is as great as 250 decibels.

Now, you will have assumed already that with the introduction of toll cable, together with carrier systems for both open wire and cable circuits, there must have been a steady and supporting growth in the demand for long distance telephone service. To give you some conception of how rapidly our toll traffic has grown, I shall have recourse to another illustration (Fig. 3). Over the period of the last twenty-five years, the American public truly seems to have become long distance-minded. This illustrates what, to my mind, is one of the important principles of engineering. We see it exemplified in many lines of industry, namely, that the volume of demand is governed by a complex assemblage of such factors as cost, convenience, ready availability, etc. In the case of the demand for long distance telephone service, unquestionably the most important factors stimulating growth have been increased convenience, reliability, speed of service, and quality of speech reproduction.

Our chief objective, of course, in providing more circuits of adequate transmission efficiency, has been to cut to a minimum the delay which the calling subscriber experiences before reaching his called party, thus increasing the value of the service and, incidentally, inducing him to use more of it—a result which in turn makes additional circuits necessary. This to-and-fro process has, of course, been influenced by periodic reductions in rates as improved facilities and a larger density of traffic have permitted. Nor should I fail to mention that one of the most important factors in this "chain reaction" has involved the development of superior operating techniques and more direct circuit routings which have been of assistance in enabling the operators to reach distant points quickly.

The Development of the General Toll Switching Plan

These considerations lead me to a discussion of what we call a general toll switching plan. It is quite apparent that when the art had reached a point where seconds counted in completing calls, very careful study indeed had to be given to the question of clipping unnecessary seconds from our operating times. Such a study had to be nationwide, giving attention to the calls that pass between far corners of the country as well as to those that flow over the heavy trade routes.

At the same time, it is equally obvious that the solution could not lie in direct circuits from each exchange to every other exchange. Such an arrangement would be too profligate and unwieldy to be commercial. On the other hand, due weight must be given to the fact that the toll business has shown a more rapid growth in the longer lengths of haul than for the shorter hauls. For example, during an interval in which the messages on hauls up to 250 miles doubled, the messages on hauls from 250 to 1,000 miles increased five times, and those over 1,000 miles increased more than ten times.

All measures of the quality of service—speed, accuracy, and transmission—show that the difficulty of giving satisfactory service increases rapidly with the number of intermediate switches. The general toll switching plan, therefore, involves the layout of toll circuits in such manner as to limit as much as practicable the number of switches required to connect any two telephones, and also the establishment of standards of design and construction giving satisfactory transmission over any route thus established.

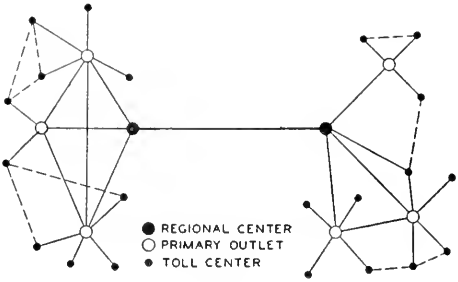


FIGURE 4

Schematic illustration of the general toll switching plan, showing the interconnection of important switching offices throughout the Bell System. Solid lines represent fundamental routes; dashed lines, supplementary direct circuit groups

THE general features of the plan will be understood by reference to Figure 4. It shows the application of the plan to a limited operating area such, for example, as a region of the United States. Within the area are selected a small number of important switching points designated as "primary outlets." Each toll center is connected directly to at least one of these outlets and all primary outlets within the area are directly interconnected. This makes possible the interconnection of any two toll centers within the area with a maximum of two switches; and, within the part of the area served by one primary outlet, with a maximum of one intermediate switch.

The primary outlets have been selected after a careful study of the switching and operating conditions and the probable development of toll traffic within the various areas with a view to obtaining the minimum number of primary outlets capable of handling the traffic economically. The routings provided by the plan are supplemented by direct circuits, or by other routings where the amount of business justifies such additional cir-

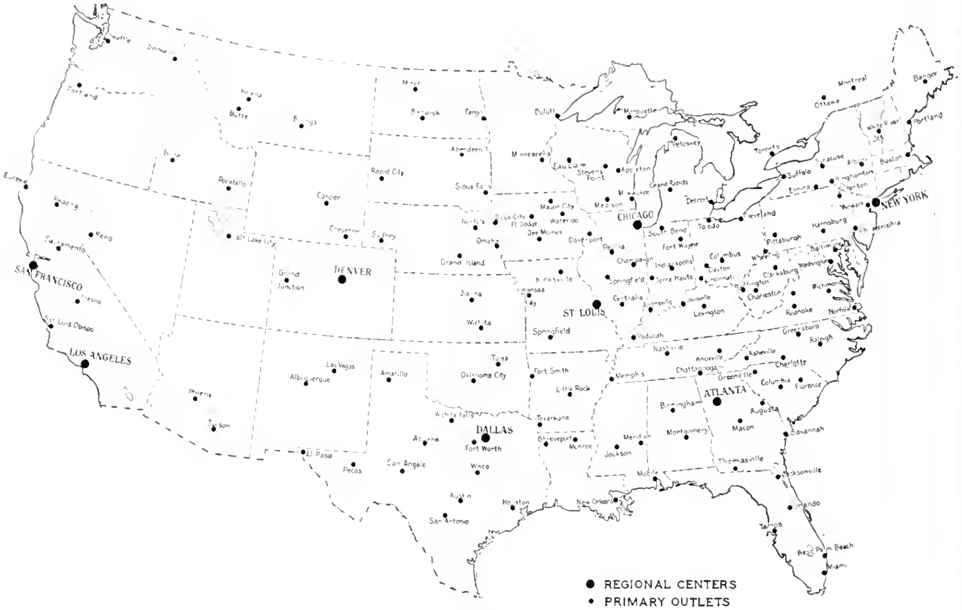


FIGURE 5

Regional centers and primary outlets of the general toll switching plan in the United States and Eastern Canada

cuits, as indicated by the dashed lines in the drawing. In general, the requirement is made that these supplementary routes shall be at least as satisfactory, as regards both number of switches and transmission, as the routes provided by the fundamental switching plan. However, when the supplementary routes are used only as alternates to a primary routing, they may be somewhat less satisfactory in these respects.

The nationwide array of primary outlets is shown in Figure 5. We have found it practicable to take care of switching for the 2,500 toll centers of the United States and eastern Canada by the establishment of approximately 150 of these as primary outlets.

To facilitate the handling of longer haul business, eight of the largest cities have been designated as regional centers. These are New York, Chicago, St. Louis, Atlanta, Dallas, Denver, San Francisco, and Los Angeles. Each primary outlet is connected with at least one regional center and with as many more as practicable. With few exceptions, each regional center is directly connected to every other regional center in the country. However, there are many more direct routes than this statement would imply. By this means, any one of the primary outlets, which are the 150 most important switching centers in the country, can be connected to any other primary outlet in the country with a maximum of two switches, and within the area served by a regional center with a maximum of one intermediate switch. As an illustration of the concentration of switching which results, New York serves as regional center for the entire northeastern section of the United States and eastern Canada.

Figure 6 represents direct circuits radiating from Chicago. You will note that several important cities in the Mountain States other than Denver have direct lines to Chicago. Furthermore, there are cities in the South which can be reached without a switch at Atlanta.

One possible ultimate development would be the increasing connection of primary outlets to a single regional center, so that ultimately only one regional center would be necessary. If this were to take place, the regional center would undoubtedly be Chicago. The illustration is interesting as showing the extent to which the primary outlets already are connected directly with Chicago, over one-half of them having such direct connection.

Future growth will doubtless lead to an increase in the number of toll centers connected directly to a regional center. By this process there would be a continued growth in the number of toll centers which can be interconnected with a maximum of two intermediate switches.

LOOKING to the future, an increasing amount of the outgoing traffic will be handled by operators in the local central offices, reaching the toll line over toll tandem trunks. It is evident, however, that the ultimate solution of the problem will involve the use of machine methods for the selection of the toll line by the operators, as is now done in certain segregated toll tandem systems.

The entire trend of recent years is thus to decrease the differences between the handling of exchange messages and of toll messages. At the

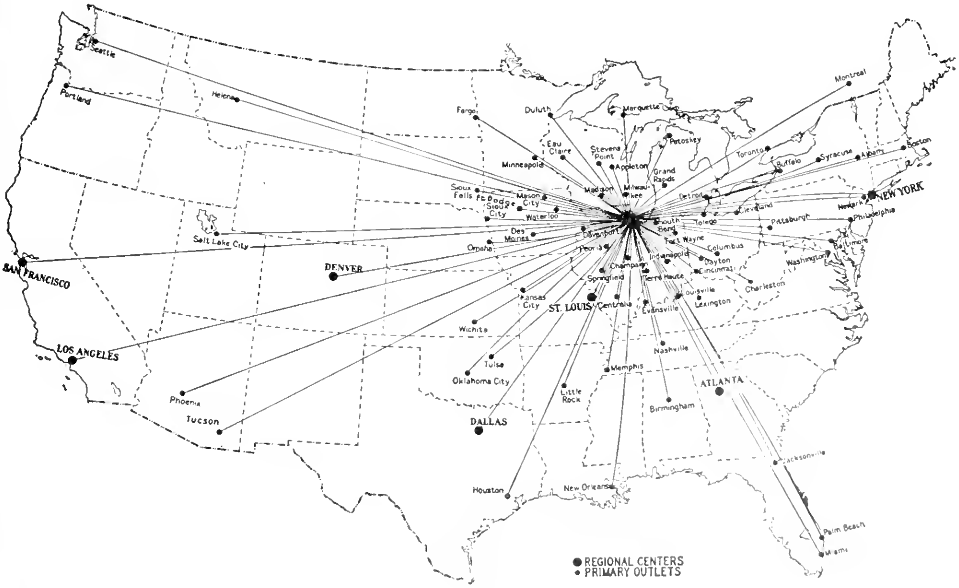


FIGURE 6

Direct circuits radiating from Chicago present time more than 90 per cent of the toll messages are completed while the subscriber remains at the telephone, with speeds of completion only slightly slower than those of exchange messages. Transmission standards, while naturally somewhat better for the shorter distances involved in exchange messages, are, nevertheless, rapidly becoming very comparable. The present view of trends for the future is for continuation of this process, perhaps even to the use of similar types of machine equipment at central offices for switching the various classes of messages.

Transcontinental Routes and the Development of Carrier Systems

IN order to justify the reference to transcontinental telephony which is contained in the title of this talk, I must return to it from time to time. I do so again at this point to mention that the original line with three circuits has now become four routes with about 170 circuits. You have doubtless surmised, as a result of the discussion of the toll switching plan, that the number of coast-to-coast circuits must have mounted steadily and that they probably were directed over divers routes. This, precisely, is the case.

Following the historical sequence, second in order of time was a line running west from Dallas (1923) and terminating in Los Angeles. This carries 31 circuits, 15 voice frequency and 16 carrier. Next there followed the so-called northern transcontinental line, which runs west from Minneapolis and terminates at Seattle, and which has six voice frequency and 16 carrier frequency circuits. Finally, there was completed about three years ago a fourth route, which runs west through Oklahoma City and, passing through Albuquerque, terminates in Los Angeles. It carries eight voice frequency and 69 carrier frequency circuits. You will see, therefore, that carrier systems predominate today in supplying the very long haul facilities.

I might add that, whereas earlier carrier systems which we developed some twenty years ago were designed to provide three and four carrier circuits per pair of wires, the latest systems to be introduced—there is a type J for open wire and a type K for cable—are twelve-channel affairs, while the coaxial cable which is now undergoing installation for commercial service will provide hundreds of telephone circuits on a single pair of conductors. Of course, these systems are and will be increasingly used on routes other than transcontinental. At the present time we have a total of nearly a million miles of carrier circuits, and so far as the telephone user is concerned, and even so far as our own traffic people are concerned, there is no distinguishable difference between a voice frequency and a carrier circuit.

EARLIER in my talk I mentioned the electric wave filter invented by Campbell. It is, of course, in connection with carrier systems that the filter finds its most important application in telephony. I shall assume that you are all familiar with its operation and so shall merely state in passing that it provides a most elegant scheme for separating at the point of reception the various messages which a carrier system handles simultaneously. You will recall that it was an outgrowth of the mathematically deduced characteristics of the loaded line. Thus, we stumble upon another interesting relationship. What we put out at one door comes around through another; for while we have dispensed quite generally with loading coils on long lines in order to adapt them to carrier operation, carrier itself would not be feasible were it not for the wave filter which grew out of the loaded line.

From carrier systems it is natural to digress for a moment to other high frequency facilities. Chief among these are the radio telephone channels, some overseas and some for ship-to-shore and harbor operation. The topic of radio telephony is pertinent to our present discussion for quite another reason, however. Some of you may recall that it was less than a year after the first transcontinental line was opened in 1915 that we succeeded in transmitting speech by radio across the Atlantic Ocean. Words emanating from the Arlington antenna at Washington were received at the Eiffel Tower in Paris, use of both structures having been granted to us for the purposes of the experiment. The vacuum tube which brought success to the transcontinental program began early to show its versatility.

However, our transatlantic equipment of 1915 was crude in the extreme compared to what proved necessary to offer a commercial overseas service. Although a one-way demonstration from New York to London was given in 1923, it was not until 1927 that the British Post Office, which operates the telephone system in Great Britain, countered with a transmitter to send from east to west. Since that time, overseas channels have bobbed up with surprising rapidity all around the earth, so that today some 93 per cent of all the telephones in the world can be connected, one to another. From the United States we can telephone to seventy-four other nations—or can when peace-time conditions prevail. One of the stunts performed a while ago was to talk from one office in New York City to a nearby office by a telephone circuit which circled the globe.

Each Success Has Inspired New Efforts in Laboratory and Field

I MUST now undertake to conclude this discussion of what grew out of one particular kernel, if you will allow me to refer to a circuit some 3,000 miles in length as a kernel. Perhaps it might better be compared to one of those long chain molecules which the chemists are employing these days with surprising results. Time forbids more than a mere mention of numerous other essential devices which are playing their part in this broad subject of present-day telephone transmission. Such things as phase correctors, automatic gain control of repeaters, volume compressors and expanders, echo suppressors, etc., ought really to receive more comment than I can give them, to say nothing of various refinements in operating techniques which have been of great importance. However, I trust that I have succeeded in giving you at least a glimpse of how some of the chapters of this technological romance have unfolded.

Thirty years ago the problems of long distance telephony and particularly the problems of transcontinental telephony were very concrete transmission problems. Because the greater obviously included all the lesser, it was taken for granted that a satisfactory solution of transcontinental telephony would have far reaching effect on all long distance telephony. For the most part we thought of the effect in terms of transmission rather than such things as speed of service or toll switching plans.

It would be easy to claim too much for the descendants of the physical things that were first utilized commercially in the transcontinental circuits of 1914–15. At the same time, it is largely because of these descendants, developed to do a multitude of things, that we have present-day national and international telephone service; that the distant party is obtained while the calling party is still at the telephone; that we have a toll switching plan and can contemplate a better one; and that we can talk about circuits which girdle the globe or operating methods which tend to wipe out existing differences between local and long distance service.

None of us who were in the game from the start, thirty years ago, were bold enough to envisage what is commonplace today. But each success as it came along inspired new effort both in laboratory and field, and by a process of probing into Nature, inductively in the laboratory and deductively by means of mathematics, and with constant study of the operating problems which our traffic people have encountered, we have, I believe, made creditable progress. I want to impress upon you that close coöperation was necessary every foot of the way. In bringing the fruits of science to the service of a vast public in a manner such as the telephone accomplishes, there has been no room for the dictatorial method, except of course as Nature does the dictating. We must try at all times to plead our case intelligently before Nature, and sympathetically before the public. As a matter of fact, the public and its reactions are as much a part of Nature as the electrons which carry our messages, and transgression of its laws of reaction would have been about as inimical to success as would a failure to understand the laws of electromagnetism.

In its journey covering a quarter of a century, telephony has, as you have seen, crossed several thresholds —but, at this, the journey may be in its early stages. If progress continues at the present rate for another twenty-five years, you will have to grant two evenings to the speaker whom you select to deliver your Steinmetz lecture in 1964.

* * *

It has been my good fortune to have had a part in a great adventure, some of whose principal features I have attempted to sketch out for you. I would be less than honest and far less than generous, however, if I allowed any of you to depart with a false impression of my personal contributions. The achievements embody the contributions of many men, my associates (some of whom I do not even know), working through the years as a team of which I have been a member.

OUR EXHIBITS AT TWO FAIRS

More than Thirteen Million Visitors Enjoyed the Bell System's Hospitality, and Learned about It and Its Services, at the New York Fair and the San Francisco Exposition

I. AT THE NEW YORK WORLD'S FAIR

By THOMAS W. WILLIAMS

"FOUR HUNDRED telephone men and women entertain eight million visitors." That is how a headline for the Bell System Exhibit at the New York World's Fair might be written. The four hundred telephone men and women and the eight million visitors of the headline are merely facts told in volume of people. The story of what was done in the name of the Bell System, and how it was received by those who came as our guests, is in the word *entertain.*

Perhaps it would be well to depart for a moment from headline technique and give exact data. The actual attendance at our Exhibit was 7,878,000, which was thirty per cent of the total paid admissions to the grounds, numbering 26,409,000. The average daily attendance was 42,600, with the maximum on a single day of 130,000 and five days having 100,000 or more. The length of time the average visitor stayed in the Exhibit was 22 minutes, and a fourth of them were there for over 30 minutes. In view of the magnitude of the Fair and the competition from other exhibits and attractions, these figures of attendance and length of visit are significant. They were influenced by three factors: the type of exhibits, the arrangement and housing of them, and the personnel who operated them.

The Exhibit was planned, as told by John Mills, of the Bell Telephone Laboratories, in the October, 1938, QUARTERLY, according to two criteria. These were: (1) the desirability of attracting participation by visitors in something of personal interest to themselves; and, (2) providing exhibits of scientific novelty comprehensible to the general public. The exhibits selected were the Demonstration Telephone Call, the Voder, two Hearing Tests, Audition, two Voice Mirrors, a Model Dial Unit, and ten displays in the Hall of Pioneers portraying a scientific presentation of development in the telephone art. Not only was participation in nearly all the exhibits easy, but they covered a wide range of human-interest subjects and they were comprehensible to the general public.

The building, from the shining gold Genius of Electricity atop its towered portion to the mosaics and symbolical panels at the entrances, its sculptures and its beautiful landscaping, has been described as among the finest on the grounds. Its interior, true in proportion and design, harmonious in decoration, and artistic in the staging of exhibits, had an atmosphere of dignity and welcome.

The operation of the Exhibit was the responsibility of the New York Telephone Company, and the personnel, of approximately 400 people, was recruited largely from its ranks.

Having, then, exhibits which were inviting because of their scientific novelty and personal benefit, and a building of both character and beauty, there remained an important complement—the manner of the personnel. Naturalness was, obviously, the desired characteristic; and in order to achieve it our people at all times regarded the visitors as their personal guests, to whom should be extended the same friendliness shown to guests in the home.

The Story of Our Exhibit—Told by Visitors

The figures of daily and total attendance have only quantitative value. They do not answer the important question: How was the Exhibit received by our visitors and how did they and the Bell System benefit from it?

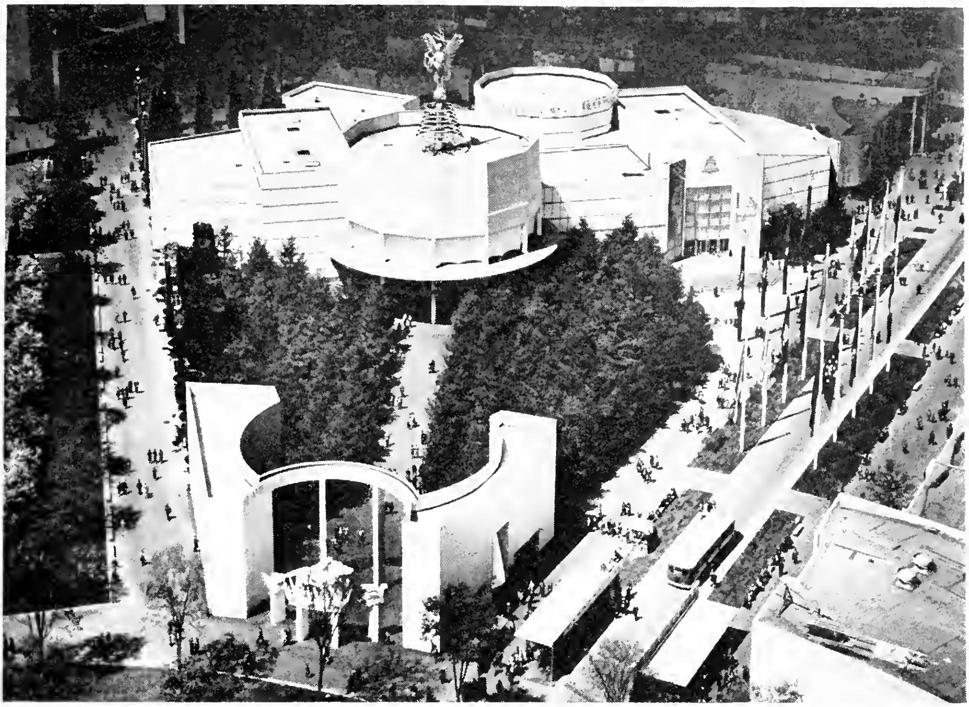
The usual way of answering the first part of that question would be to describe the color and human interest of crowds when they are on the hunt for pleasure and scientific novelty. In other words, to write of the Exhibit and its crowds objectively. There is perhaps a better way, and that is to treat the matter subjectively.

During the course of the Fair, visitors by the hundreds voluntarily expressed to members of the operating personnel, by word of mouth and by letter, their impressions of the Exhibit. The manner of calling these visitors as our witnesses will be to quote just a few of their typical comments as they relate to each part of the Exhibit.

The Long Distance Demonstration

In the six months of the Fair, more than 540,000 people filed applications for demonstration calls, and 30,000 were successful. It is estimated that 1,500,000 listened in. These calls were made to points all over the Nation. Where a call was to a telephone served by one of the country's 6,000 non-Bell companies, the connection was completed through the courtesy of the telephone company operating in that area, under arrangements endorsed by the United States Independent Telephone Association. To those participating, either by winning a call or by listening in, these conversations were endlessly amusing. The startled ejaculations of the person called on being notified of the identity of the call, and the warning by the person calling—emphasizing the operator's formal notice—that because people were listening in, the conversation should not divulge family secrets, were the refrain of almost every call.

At times hilariously funny, at times merely hum-drum, at times revealing the finer instincts in human nature, and containing always the element of



THE BELL SYSTEM BUILDING

Taken from high up on the "Trylon," this picture gives in perspective a view of the structure in which thousands of visitors each day were welcomed and entertained

the unknown, these calls never failed to attract as a unique portrayal of human behaviorism. From the opening day in April to the close in October, applicants were always in line, and the 270 listening-in receivers were constantly in use, so that the crowd made the show its own and had a grand time doing it. There were comments by the score showing keen appreciation of the speed and quality of the service. Of course, the conversations brought out countless amusing incidents. To select a few of them would be easy, but to do them justice would require the talent of O. Henry.

There was one unique incident. Early in the summer a letter was received from a young man in a distant state saying he had talked with his fiancée from our Exhibit. He wrote that, emboldened by the thrill of the call and by recent employment, he had, during the conversation, proposed marriage, and the girl's answer had been *yes*. He believed his cup of joy would be completely filled and our publicity greatly enhanced by a marriage ceremony at the demonstration call exhibit in our building, for which he offered himself and fiancée as principals—for a consideration. The reply to his letter stated why his plan

SOME OF THE FOUR HUNDRED

This group is representative of the entire Exhibit staff, whose courteous and friendly attitude created good will for Bell System men and women everywhere

could not be accepted, and concluded with best wishes for a happily married life. Then, just prior to the close of the Fair, the writer received an invitation to the wedding.

But we were to call the witnesses, and here they are:—

"My biggest thrill at the Fair was when I heard a little girl speaking to her mother in St. Louis."

* * *

From a young woman: "This is the most interesting exhibit at the Fair. The long distance demonstration is simply wonderful."

* * *

A manufacturer said he was much impressed with the long distance demonstration. He added that the Exhibit not only displayed the speed with which calls are handled and the national scope of the service but also demonstrated making or receiving a long distance call, the thrill of talking across the continent, and the thousand and one little things that go to make up the daily conversation of the nation.

* * *

Elderly man: "I heard a conversation clear across the United States. What a thrill!"

* * *

A man said he had heard so much about the toll call demonstration, he came into the Exhibit just to see it. He commented on the speed with which connections are established, both here and from regular telephones.

The Voder Amazes and Amuses

During the last two centuries, scientists have been endeavoring to produce speech synthetically. It remained for Bell System research specialists to be the first successfully to achieve a complete result. If a visitor entered the Voder room and joined the listeners, he saw the Voder being operated and heard what could be done with it. But if he stood at

a point from which he could hear it and at the same time look into the faces of the listeners, he saw impressively the effect it had upon them. That they were hearing something of startling scientific import and profound human interest was obvious from the expressions on their faces, for uniformly they listened in rapt and appreciative attention.

The dialogue between the man at the microphone and the girl at the Voder proved a happy combination of scientific explanation and almost casual conversation. Then, at the point in the program where the visitors were invited to suggest words for the Voder to say, the crowd took the show over. Oshkosh, antiphlogistine, Tuscaloosa, antidisestablishmentarianism, Popocatapetl, onomatopoetic, Saskatchewan, the spelling of Mississippi—these were some of the favorites. And always at the lilt of the last two syllables of Minnehaha the crowd roared.

It is estimated that the number of visitors to the Voder room exceeded 5,000,000. Here is what the witnesses say:—

"That machine is a wonderful accomplishment, and demonstrates the skill of telephone engineers in handling problems of speech."

⁂

Man from U. S. Patent Office: Stated he had visited the Voder demonstration several times and it is the most remarkable of anything he had seen at the Fair.

⁂

"Is is true that there really is no phonograph record? My, it's amazing!"

⁂

Elderly man: "The miracles, as the Bible describes them, are really true, for here in this room we are witnessing a modern miracle. The wonders of God transmitted through man's mind are truly being demonstrated here."

⁂

"I am tired of the regular Voder demonstration. I have heard it 19 times and I come in now only to hear the Voder try new words. I visit your Exhibit on every trip to the Fair."

⁂

ACROSS THE CONTINENT

The long distance demonstration was spectacular to watch as well as fun to listen to

A man said that the Voder is a wonderful example of the advancement the telephone industry has made in the technical research of sound and speech.

* * *

"The Voder is just marvelous and so is the girl who is operating it."

* * *

Woman Science Teacher: Said that, in her opinion, the Voder is the nearest approach to a human function in science.

* * *

Professor of Oriental Languages: Said he was impressed by the mechanical and electrical marvels of the machine. He had an idea of the difficulties which had to be surmounted because of his experience in teaching Arabic and other languages by phonetics. He added that he intended to put our Exhibit on the "must" list for his associates on the faculty.

Hearing Tests Were Very Popular

AMONG all the exhibits at the Fair the hearing tests ranked high in novel appeal and personal benefit. That they were so considered is indicated by the fact that the tests given to visitors totaled 1,700,000. As visitors completed the tones test, girl attendants entered check marks on completed test cards showing sex, color, and approximate age of the visitor. Recordak photographs were then made of the test cards. It is the first time information of this kind has been available in such volume, and its value to telephone engineering and the whole field of human hearing is substantial.

THE witnesses say:—

Man: Said the Bell System is doing mankind a real service in providing hearing tests. He added he was much impressed by the girls employed at the Exhibit.

~

"My left ear is better than my right ear. I am certainly surprised to know that."

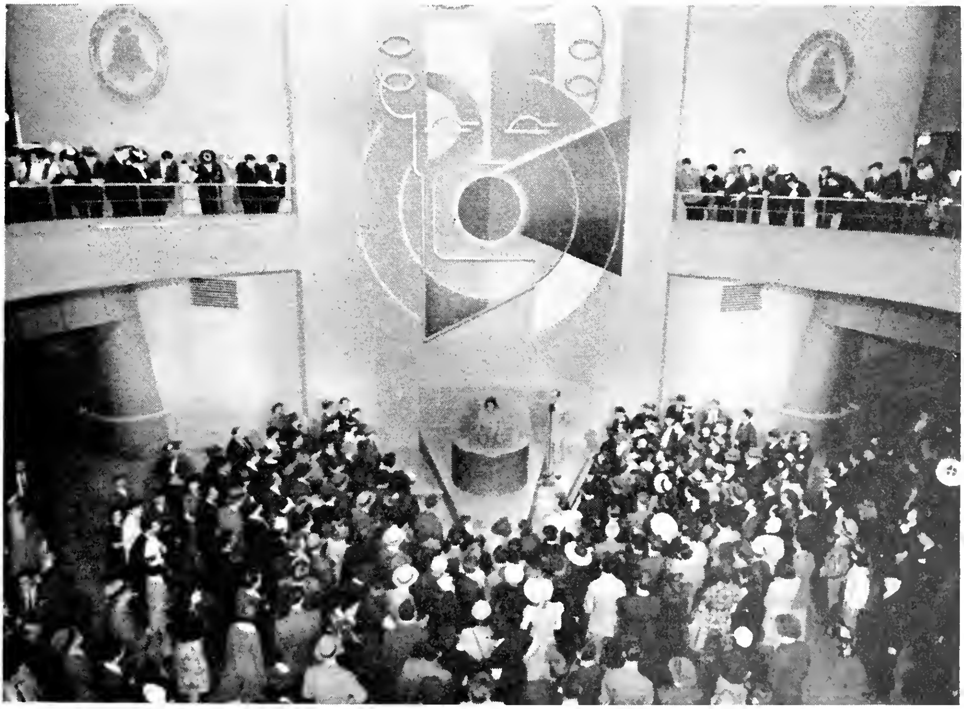
~

Woman: Said she had taken a hearing test a month ago and her hearing was slightly impaired. Since then she had gone to an ear doctor for treatment, and this test now showed her hearing perfectly normal.

~

"I am a railroad engineer and always thought my hearing was impaired by the wind when I ride with my head out of the locomotive window. It is the surprise of my life to find my hearing normal."

~



THE VODER FASCINATES THE CROWDS

The manipulative skill of the operator's fingers makes the Voder's voice almost too good to be true

Man: Said he failed to hear the high frequencies in the tones test and this had convinced his wife he did not and could not hear the squeak in the family car. He added this argument had been going on for some time.

—*As Others Heard Them*

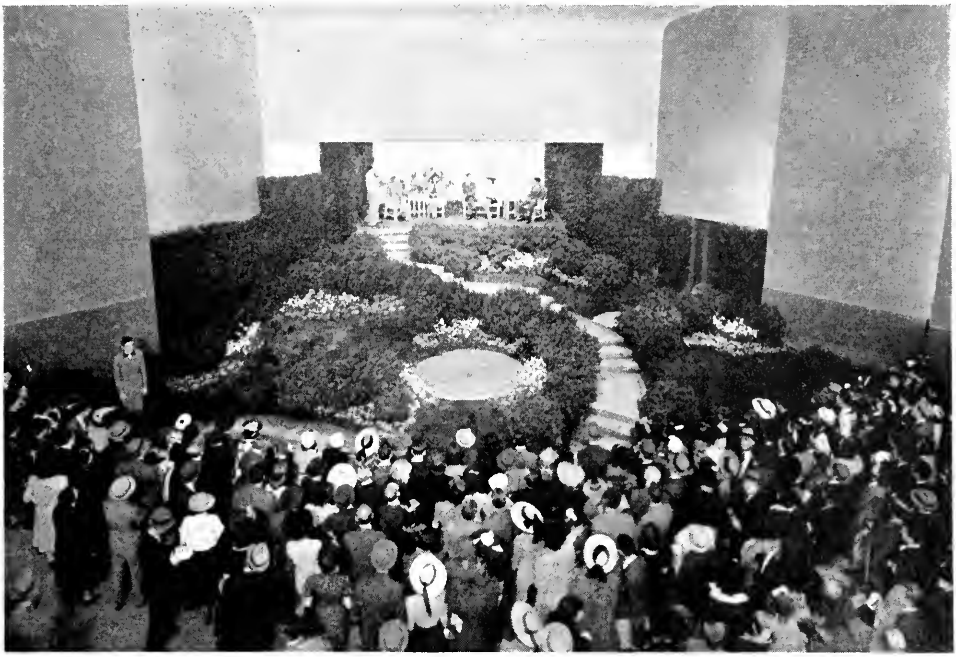
In attempting to describe our exhibits, one is conscious of the limitations of space. This is particularly true of Audition, for it would be easy to write of it at great length. The attractive garden scene, the informal social conversation between a group of visitors and an Exhibit man directing the conversation, the substitution of mannequins for the visitors, and the high-fidelity reproduction of the conversation made a diverting show which attracted audiences of lively interest.

At the opening of the Fair the public seemed to appraise Audition as something of a stunt. But almost immediately it came to be regarded as an entertaining event by everyone, and as an experience of direct personal benefit by many of those who participated.

Again and again individuals who had been unsuccessful in winning a chance to participate requested that they be permitted to try it. The requests came from teachers, clergymen, vocal students, lawyers, doctors, from those with impediments of speech, from those who considered the opportunity of hearing such an accurate recording of their voices as helpful in their occupations, and from those who regarded Audition as a means to better habits of speech.

LINING UP—

—*for hearing tests, which were of interest to hundreds of thousands*



AUDITION! HEARING THEMSELVES AS OTHERS HEARD THEM

The dummies on the stage appear to be repeating the conversation just completed by a group now seated at the foot of the garden

On rare occasions, instead of a group of five visitors, one person gifted in the art of pleasing conversation would be given an audition alone by an Exhibit man. These diversions were always entertaining.

Of course, the purpose of Audition was to give people an opportunity to hear how their voices sound in normal conversation. This was pointed out to each group in the short preparation period before its audition and it was urged that the replies to the interlocutor's questions include at least three or four sentences. But there were some groups in which all five people responded in single words whenever possible; the shorter the better, they seemed to think. In such cases the most successful Exhibit man, bombarded by these bullets of brevity, could get nothing but grief for himself and zero for the audience. Fortunately, they were few in number. In fact, a survey developed that, judged by rather severe standards of measurement, three-fourths of the shows could be classified as excellent or good and most of the others as fair.

OVER 100,000 participated in Audition, and it is estimated that nearly 6,000,000 stopped to watch it. The witnesses say:—

"I have been troubled by stammering, and my voice teacher suggested that I visit your audition exhibit. I have heard myself talk and it was the thrill of my life."

Man from Northern Canada: "Up home, when anyone says he is going to the World's Fair he is bound to be told, 'Don't forget to go on the stage where you hear your voice in the Telephone Exhibit—it is the best thing at the Fair.' "

* * *

Man from England: Said he was told about Audition by a friend who met him at the boat that morning. He said we have "a grand show, just full of human kindness."

* * *

Woman: "As a cooking teacher, I address large groups of women and I am interested in knowing how I sound to them. Your audition has been the high spot of the Fair to me."

* * *

Woman from South Africa: "I am in the States for a visit and have seen quite a bit, but an opportunity to hear myself speak was not anticipated. All the wonders I have seen and the things I have done since coming are overshadowed by this experience."

* * *

Woman University Teacher: "This equipment should be made available for every teacher of speech in the country. One audition has far more value to a student of speech than hours of reading before a critical audience."

* * *

An Assistant Attorney General: Said he came to our Exhibit especially to hear his voice, and used the same tone and volume he ordinarily uses in a courtroom. After the reproduction he said, "I always knew I could fill a room with my voice but I found out today how easy it is to empty one."

Voice Mirrors Have Wide Appeal

Wherever used, this exhibit has wide popular appeal. Voice mirrors were provided at two locations in the building, and it is estimated that 1,100,000 talked into them and 1,500,000 listened in but did not talk. Comments are:—

Elderly blind man from Colorado: "My boy said they call this the voice mirror, which in my case is well named. For the first time in 25 years I actually did see, you might say. My voice was reflected in my ears, which both see and hear for me."

* * *

"I like the voice mirror because I'm a teacher and now I know how I sound to my students."

* * *

Man from Colombia, South America: Said he had talked with people in South America who visited the Fair and had been advised to visit the Bell System Exhibit. His friends had told him particularly about the voice mirror.

* * *

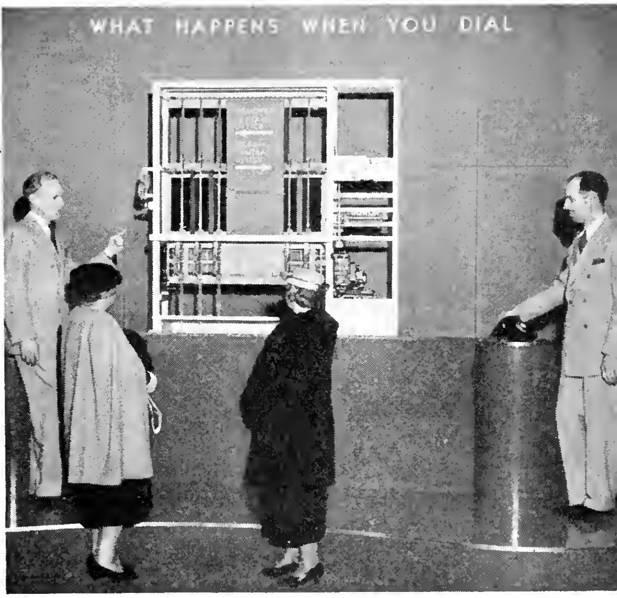
Middle Aged Woman: "It is indeed wonderful to talk into a telephone and have your own voice come back to you. It's a great age to be living in."

* * *

Elderly Woman: "I want to hear what I sound like on this contraption"; and, after trying it, "I think I have a real nice voice for an old lady."

The Model Dial Demonstration

This exhibit was a small assembly of panel-type dial equipment about five feet wide and four feet high. The demonstration, given by one of the Exhibit men, consisted of dialing a call from a telephone in an originating central office to one in a distant office.



The demonstration of dial operation helped many to a clearer conception of how the service is provided

The apparatus was equipped with the five essential selectors, rotary and sequence switches, and message register. Demonstrations went on continuously. A dozen listeners was a small group and the exception, with the number ranging occasionally up to well over a hundred, the capacity of the available space. The close attention of the listeners indicated their genuine interest in an opportunity to see What Happens When You Dial—which was the designation on the wall above the exhibit.

At the conclusion of each demonstration, visitors were invited to ask questions. They were always curious about the electrical registration of calls, toll charges, the operation of the busy test, those involving mechanical features, and a wide range of telephone subjects. These discussions were of the most friendly sort and both questioners and listeners seemed to enjoy them. It is estimated that 900,000 witnessed the demonstration. And here is what some of them say:—

"I have frequently been skeptical concerning your accuracy in billing additional local messages, but now I believe your system of recording and compiling local message charges is excellent."

* * *

"We have dial service at home and I have always wondered how it works. I was interested in the dial demonstration but I still think it quite complicated."

* * *

"This is the most enlightening and enjoyable scientific display I have ever seen. It acquaints the public in an understandable manner with the dial system. The average individual should be able to appreciate the vast improvement that the dial system brings."

* * *

"How interesting! Now for the first time I feel that I understand what happens when I dial!"

* * *

"The maze of equipment in a dial office has always puzzled me. You have given me the simplest and clearest explanation I have ever heard."

* * *

Man: Said he and his wife enjoyed the dial demonstration greatly. He added he never gave much consideration before to what actually happened when he dialed but just took it for granted.

* * *

Man: Said he had always attributed his high bills to the fact that he was charged for "busy" calls. He added he was glad that he had stopped at the dial demonstration and learned that his register does not operate on "busy" calls.

The Hall of Pioneers

The exhibits in the Hall of Pioneers, in addition to a large voice mirror, were chiefly displays of telephone apparatus, showing the improvements that have been made in cables, coils, central office equipment, and telephones. The oscilloscope, which made visitors' voice waves visible when they spoke into it, was always a source of amazement. Men were available to explain the exhibits to visitors and many comments of appreciation were received.

Pioneer Lounge, the gathering place for telephone people from all parts of the System, was well patronized, the registrants numbering nearly 4,500.

The comments given thus far relate to specific exhibits. Many others were either of general nature or referred to the personnel. Here are a few of them:—

"This seems to be the only exhibit at the Fair visitors can take part in."

* * *

"As a stockholder, I am proud of your Exhibit and I'm glad that a part of my investment is used to create a better understanding with people."

* * *

"The shrubbery and trees about your building are beautiful. I just had to take a photo of it."

* * *

Two visitors from England: Said they had been advised by friends who had returned to England to visit the Bell System Exhibit as a "must" item on their trip.

* * *

Man: Asked what school of diction had been attended by the Exhibit staff. Said he had never heard better diction in any group than he had from the men and women in this Exhibit.

* * *

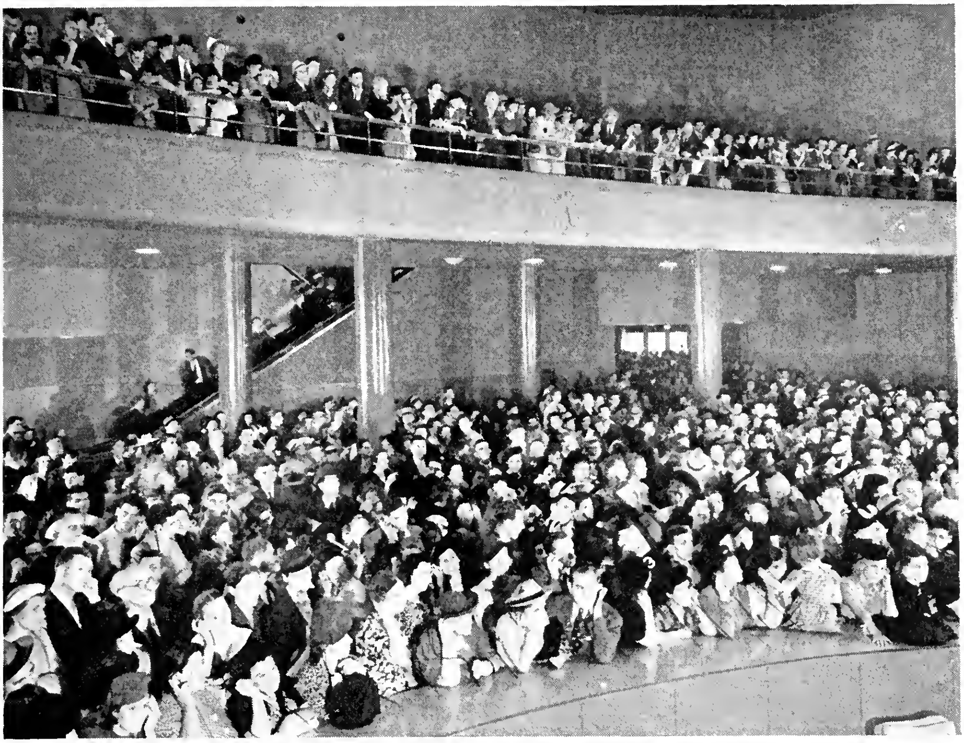
Man: "So all these girls are telephone operators? And to think how sassy I have been to them over the telephone."

The exhibits contained many complex circuits and much intricate apparatus, and it is to the credit of the plant maintenance group that they were so effectively conditioned that there were no serious failures and the few interruptions were of minor character.

It should be said that the operating force—the supervisory staff, instructors, men, girls, pages, guards, porters, all of them—at all times were conscious of the fact that courtesy and friendliness on their part would be accepted by the public as recognized qualities of the great organization they represented. And they so maintained this standard that not only were there many comments of appreciation for their treatment of visitors but also regarding the attitude and relationship of the personnel toward each other.

To repeat part of a question raised earlier in the text: How did the visitors and the Bell System benefit by the Exhibit? Well, the visitors, by the crowds in which they came, by the enthusiasm with which they participated, and by their comments, some of which have been quoted, have spoken for themselves.

And how did the System benefit? In many ways. In a building of inviting dignity, people found exhibits which were interesting, entertaining, and in many cases personally helpful. Most of the things they saw and did were indicative of the part research plays in providing present-day telephone service, and all of them were



"PEOPLE ARE LISTENING IN"

Receivers bring the demonstration long distance calls to listeners on the ground floor, while visitors on the balcony watch the progress of the calls across the great map and even those on the escalator try not to miss anything

expressive of the wide scope of the System's undertakings. Visitors took away with them an impression of the courteous treatment which is representative of the attitude of telephone people everywhere toward the public.

Not least valuable to the System was the knowledge of the speed, extent, clarity, and convenience of our long distance service gained at first hand by the 30,000 who made demonstration calls—and the equal number who received them—and by the 1,500,000 listeners who partook vicariously of the same experience. The opportunity to give such large numbers of people, from all sections of the country, direct and personal acquaintance with those features of the service occurs only at world's fairs, and is, indeed, one of the principal advantages of System participation in these expositions.

Eight million people came to the Bell System Exhibit. However long they stayed, however many of the exhibits they saw or heard or took part in, they left, we may confidently believe, not only with an increased knowledge of the System's services but with a better appreciation of its methods and its aims as they were typified by the building, the individual exhibits, and the personnel.

II. AT THE GOLDEN GATE EXPOSITION

By LAURENCE N. ROBERTS

On February 18, 1939, the Bell System Exhibit at the Golden Gate International Exposition was launched with high hopes. On October 29, 1939, when the curtain was rung down at the close of the Exposition, those hopes had been proved to be well justified.

Throughout the year it became increasingly evident that the Exhibit had a wide popular appeal. Indeed, it is easy now, looking back, to see that in the conception of the several demonstrations the probable reaction of the public was accurately gauged. We feel that great credit is due to John Mills, of the Bell Telephone Laboratories, and those associated with him in designing the Exhibit, for their clear preconception of this situation.

The following letter from a visitor, which expresses this thought, is, we believe, typical of the feeling of a majority of persons who visited our exhibit:

> "Since the day the Fair opened, I have visited the Island twelve times, and on each occasion I make it a point to spend some time at your exceptional exhibit. The American Telephone and Telegraph Company is to be congratulated on presenting the smartest exhibit at Treasure Island. Whoever presented the idea deserves a world of credit, for from the public relations standpoint, it couldn't be better. I have no favor to ask; I just feel like remarking on an excellent job well done."

From the outset, the public rated the Bell System Exhibit one of the most attractive and interesting at the Exposition. Very rarely did people enter into a discussion of what to see on Treasure Island without putting the telephone exhibit on their "must see" list. When people were overheard discussing what they had seen at the Exposition, they invariably spoke of our Exhibit as an outstanding attraction. Also, when one stood at the exit of the Exhibit listening to the comments of people as they were leaving, one continually overheard such comments as, "Isn't this a grand exhibit!," and "This is certainly an interesting exhibit."

The attendance figures graphically illustrate the popularity of the Exhibit. Of the 10,496,000 persons who paid admission to the Exposition, approximately 5,334,000, or 50.8 per cent, visited the Bell Telephone System Exhibit. The average length of time visitors remained was about 30 minutes.

The popularity of our Exhibit was not, we believe, traceable to any particular demonstration. Each showed its value in attracting people. This is borne out by the following analysis of results obtained by the various demonstrations.

The Long Distance Demonstrations

The demonstration of long distance telephone calls undoubtedly caused more repeat visits than any of our

EXTERIOR OF THE BELL SYSTEM EXHIBIT

It was housed in its own structure within the Palace of Electricity

other demonstrations. Many people who were frequent visitors to the Exposition made it a point to apply for a demonstration call on every trip to the island. Some persons spent an entire day in our Exhibit.

During the period of the Exposition, nearly 546,000 visitors made application for demonstration long distance calls. Of these, more than 37,000 were given the opportunity to place calls. Approximately 82 per cent were completed. Of those not completed, "don't answer" accounted for 75 per cent.

Calls were handled to places in every state of the Union and the District of Columbia. In cases where calls were to points served by non-Bell telephone companies, connections were completed by the companies operating in those areas, under arrangements endorsed by the United States Independent Telephone Association.

The length of time people listened in on demonstration calls varied from a few moments to several hours. A majority of the receivers were in use all day. As a matter of fact, the occasional inability of people to find available one of the 125 receivers added to the popular interest in the demonstration and caused many return visits.

However, participation was not requisite to enjoyment. Many visitors who did not apply for a long distance call or listen in expressed themselves as being pleased with this demonstration. Because of the attractive appearance of the map, with its brilliant chain of lights indicating the path of the call, the illuminated sign which indicated the city and state to which the call was going, and the "thermometers" showing the length of time for each step of the call, crowds of people stood watching the map for considerable periods of time with evident interest.

Many comments were received from the public, both orally and by letter, expressing their appreciation for this demonstration. The following excerpts are typical of comments received:—

"I have talked by telephone from many states of our nation, but never have had the thrill or enjoyment that the free call gave myself and my wife, who talked to her mother in St. Louis, who was celebrating her 80th birthday."

* * *

"From an advertising standpoint I do not suppose I was the best prospect chance might have selected to win one of your free calls; but if the occasion ever arises I am sure that I will use the long distance telephone without hesitation, now that I have experienced the speed and satisfaction which arise from a person-to-person cross country conversation."

* * *

"I think your exhibit has brought more happiness to people, by allowing them to call old friends and relatives, than any exhibit on the island or anything your company could do."

* * *

A visitor was talking to a friend in the east. The person who was being called said, "Now that the Fair is over

ALWAYS POPULAR

The long distance demonstration was never without applicants for calls nor crowds to watch and listen

The voice mirrors provided entertainment for many, and instruction too

I will miss hearing from you," to which the visitor replied, "But you will still hear from me. I am going to skip a few shows and call you once a month."

* * *

"I wish to express my appreciation for an Exposition free call to my son at Princeton, New Jersey, which I won at your exhibit yesterday. Many of us are prone to overlook the courtesy extended by your company in the placing of a transcontinental call without charge, taking the fact for granted, and dismissing the matter from our minds after its completion."

* * *

"My only purpose in writing this letter is to let the proper parties know that there is at least one person who realizes the expense attached to this free service, the clarity of the conversation, and the courtesy of the attendants at the booth, and I take this means of making my appreciation known."

Visitors asked many questions about the cost of the calls placed. In each case we presented the questioner with a booklet showing rates from Treasure Island to one or more points in every state. Almost invariably people were surprised at the low cost of telephoning. They usually thought the charge would be two or three times the rate shown in the booklet. Comments made to our people at the Exhibit indicated that many commercial calls have resulted and that many people are beginning to use long distance who had not used it before.

The Voice Mirror Was Popular

THE voice mirror was a very popular demonstration, despite the fact that it has been shown at telephone open houses and at the other recent exhibits of the Bell System. During the busy periods of the day people stood two and three deep waiting for the opportunity to participate. Approximately 900,000 people listened to the reproduction of their voices, and many more than this number participated by listening on the receivers to this interesting test. In some cases people returned for repeated demonstrations in an endeavor to correct speech difficulties.

A gentleman complained to the voice mirror receptionist that he had difficulty being heard over the telephone. He said that he had been embarrassed many times by having telephone operators address him as "yes, Ma'am." Observation of his use of the voice mirror telephone disclosed that he spoke very softly and not directly into the telephone. When these faults were called to his attention, the results were greatly improved, much to his delight.

A humorous incident occurred which concerns a foreign gentleman and his family. He said into the voice mirror, "I live at (—) 25th Avenue." When it was repeated back to him, he became very indignant, exclaiming, "I didn't say 55th Avenue. I

Opportunity to test the acuteness of their hearing was welcomed by thousands

said 25th Avenue, 2–5 Avenue." His family tried to explain to him that he did not enunciate clearly, but had difficulty convincing him that the voice he had heard coming back was his own.

Many Tested Their Hearing

THE hearing tests showed a steady increase in popularity from the opening of the Exposition. By April 20, some 70,000 visitors had participated in the hearing test demonstrations, or an average of about 1,100 per day. By the end of the Fair about 383,000 people, or an average of 1,500 per day, had taken the tests. Initially, visitors displayed no preference for a particular test. The demand for the tone test, however, increased from month to month. After August 1st we completed more tone than word tests.

From the start of the Exhibit until about October 1, we photographed all results of the hearing tests by running the cards, which had been filled out by visitors, through a recordak machine. The films were then sent to the Bell Telephone Laboratories for study. Visitors coöperated wholeheartedly in offering their cards for recording, and many were complimentary to the Bell System for this valuable social service.

Many people expressed appreciation for giving them the opportunity of personally determining the quality of their hearing. We received a number of requests for information concerning hearing aids.

One comment received from a visitor is indicative of the value placed on this test by participants. The results showed that the hearing of his left ear was considerably below that of his right ear. He stated that, while in the past he had complained about the quality of telephone service, he now knew the difficulty lay in his own hearing and as a result he planned to use his right ear for hearing over the telephone and not complain about the service any more.

A woman reported to us that on taking the hearing test she found that one of her ears seemed somewhat defective. She immediately went to her physician and had a thorough examination. He found in the apparently defective ear a badly packed wax condition, which, when removed, restored her hearing to normal.

Another comment: "I know my hearing is all right, but I'm an ear specialist in San Francisco and you'd be surprised at the number of people who come to me for advice after taking the test, so I want to find out all about your test."

The Marvelous "Machine That Talks"

THE Voder, like the hearing test demonstration, increased in popularity through word of mouth advertising by visitors. People stood in openmouthed wonder listening to the demonstration, and a majority stayed through more than one program. They were enthusiastic in their response during the period when visitors were invited to suggest words for the Voder to say. They viewed the "machine that talks" as a scientific marvel and an exceptionally entertaining program.

We feel that the Voder not only impressed visitors with the value of research work being done in electrical communication by the Bell System, but also played an important part in building good will through the friendly entertaining program. By the end of the fair approximately 2,000,000 people had listened to this demonstration.

On September 13, the National Broadcasting Company made a fifteen-minute broadcast on a Coast-wide hookup of the Voder program from the Exhibit over Station KGO, San Francisco. In addition to the regular Voder program, the announcer described the machine and interviewed a Voder operator, the chief technical man, and the manager of the Exhibit. On September 14, the General Electric short-wave station KGEI re-broadcast the program by electrical transcription to the Hawaiian Islands, the Orient, and Alaska. A few weeks later a visitor who had just arrived from China stated that she had listened to the broadcast in Shanghai and that the

THE VODER SPEAKS—

—and visitors crowd about to wonder at this scientific marvel which creates words at the touch of a girl's finger-tips

A STUDY IN EXPRESSION

The contrast in facial expressions in the "candid camera" pictures above and on the opposite page tells better than words of visitors' reactions to the Voder

Bell System Exhibit was her first objective on arriving at Treasure Island.

When a group of sailors from the British cruiser "Orion" entered the Voder room, the Voder greeted them with "Hello, Orion." The sailors were greatly pleased and one fellow practically exploded with laughter. At the height of his merriment, he slapped his leg and said "Not 'arf bad, not 'arf." They had seen a news reel of the Voder in Bermuda, and as soon as they set foot on Treasure Island they made a bee line to our Exhibit to see "the machine that mykes speech."

Staff Members Realized They Represented the Entire Bell System

IN preparing for the operation of the Exhibit, we realized that while the set-up of the demonstrations insured popularity, good will would be furthered by creating a truly friendly atmosphere. This goal was reached through the whole-hearted efforts of the men and women who formed the personnel of the Exhibit. Helpful, interested, and friendly, these telephone employees were actuated by real loyalty. They sincerely wanted the public to leave our Exhibit with an enhanced appreciation of the spirit of service in the Bell System. We also realized that we were not building good will for the Pacific Telephone and Telegraph Company alone but that we were operating this Exhibit in the interest of the entire Bell System, and that the attitude and conduct of our personnel would affect the opinion of the public in regard to all Bell System people.

All members of the Exhibit personnel, with the exception of the page boys, were selected from the operating forces of the telephone company because they were already imbued with a basic loyalty to the Bell System

and were actuated by the spirit of Bell System service. For the same reason, the pages were either the sons or close relatives of Bell System employees. The young women on the Exhibit staff were chosen not only because of their pleasing appearance but because of indications through their work and through activities outside their jobs that they were interested in people and the activities of their community.

THE development and training of the personnel was based on a program of reviewing with each person the background of the telephone business, and the policy, relationship, aims, and ideals of the Bell System, in order to build a sound foundation upon which to base a feeling of personal responsibility in representing the Bell System to the public. In all our contacts with them we stressed the fact that the public's good will could be earned only as they entered into a real partnership relation for the success of the Exhibit. All readily recognized that they were, in a real sense, giving up their private lives to work in the spotlight of public attention as representatives of all Bell System people.

The response of the personnel to this method of treatment greatly exceeded our expectations. This is indicated by the following letter which was recently received by the manager from one of the young ladies of the Exhibit:

"During your farewell talk the other evening you thanked each of us for our individual work at the Exhibit.

"To be one of those chosen to represent such a great corporation as the Bell System is an honor itself, so I am writing these few lines in sincere appreciation and to thank you for such an opportunity. It will long be remembered.

"The Exhibit being the success it was could result only from close cooperation between employer and employees.

"I am sure that all of the receptionists feel, as I do, that it was a great pleasure working for you and with you."

In order to develop and maintain this spirit, consideration was given to every detail of our operations in the light of employee reaction. Meetings were held to discuss the improvement of performance, and many suggestions were received which materially improved the operation of the Exhibit.

Trips "Behind the Scenes"

WHENEVER visitors wished to see the mechanical equipment, a technical man was called who escorted visitors behind the scenes and explained the operation of the equipment. During the 254 days of the Fair the mechanical equipment was shown to more than 4,000 people. Each group averaged about 2.2 persons and the average time required for the explanation was 22 minutes. These technical excursions elicited many favorable comments from the visitors.

To lessen formality and aid in creating a friendly atmosphere, regular uniforms were not provided. Instead, tailored dresses for women and business suits for men, uniform in character, were furnished. The women were fitted with a French blue serge dress and bolero with navy blue collar and cuffs. The men's suits were conservative double-breasted cadet gray worsted. Pages wore single-breasted suits of brown serge.

The dresses worn by our young ladies attracted much favorable comment, such as:

"Your uniforms are the most attractive at the Fair. The whole force makes a marvelous appearance."

~

"I certainly like your dresses. Will you please tell me where you had them made so that I may get the pattern?"

Particular attention was given to the reception and entertainment of members of our own and other Bell System companies. The Exhibit personnel realized and attempted to convey to these visiting telephone people that we were not only happy to see them but also we felt that this was their Exhibit; in other words, that we were conducting the demonstrations in their interests. We not only explained the Exhibit to them and urged them to participate, but, whenever they showed a desire, we took them back of the scenes and explained the mechanical equipment and set-up.

THE comments which we received from visitors orally and by letter convince us that we accomplished, in a large measure, through the Exhibit the results we sought. A few of the oral comments follow:—

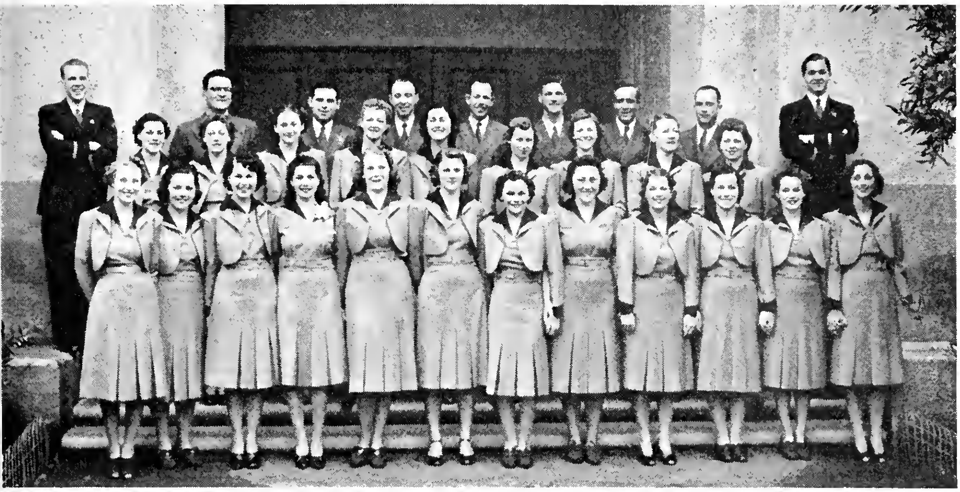
The president of a large trust company of New York stated that the thing which impressed him about our Exhibit was the friendly, helpful atmosphere that was felt as one entered the Exhibit.

~

One lady approached a receptionist and said, "I have not been here for some time but it is nice to see all you girls still with a smile."

~

A man in the hotel business told us he could not understand how it was our girls were so promptly on the job all the time, constantly smiling, and willing to give prompt, pleasant, courteous and accurate answers to all questions, until he noticed that we moved



SOME OF THE SEVENTY

Smiling and alert, this group is typical of the entire Exhibit staff

them from position to position so they did not get stale on any one position.

Following are excerpts from some letters of commendation which we have received:—

"May I also add that the very nature of your Exhibit, with the aid of your pleasing staff of employees, creates an air of friendliness and a spirit of good will not equaled elsewhere on the Island."

~

"To me this would seem to epitomize the spirit of The Pacific Telephone and Telegraph Company—that of personal service, personal interest, personal responsibility."

~

"Words are paltry to express my gratitude to you for this great favor. Your own pleasure in the knowledge of one more service for humanity must be the greatest satisfaction you can know."

~

"May I express my complete and sincere gratitude for your excellent service, courtesy and graciousness."

~

"This kindness and joy is being spread like the crumbs of bread which were cast upon the water and will return in the future."

~

"I have never written a fan letter. Many times I have been tempted to when I encountered something particularly outstanding, but this time I cannot ignore the urge to write. I have never in all my experience, and I have gone much and far, enjoyed such courtesy as I have from each and every one connected with your Exhibit at Treasure Island. It makes the heart thrill to find everyone so eager to be helpful."

~

"I was so very much impressed at the pleasant, efficient service and courtesy I received from the time my number was called until the call was completed. I realized the thousands of calls that had been made before mine, yet each person that was necessarily contacted to complete the call seemed as happy and interested as I—and certainly explained why the Bell Telephone Company is the huge company and success it is."

* * *

"It is indeed difficult to understand how any group of workers can labor with and endure the foibles of a conglomerate public for hours at a time and still retain such a pleasant attitude. The treatment I have personally received at your Exhibit will always be remembered as the high light of the Fair."

* * *

"I believe that I was in a proper position to judge your employees last Sunday, and every one of them, from the manager to the messenger boys, were outstanding for their politeness and their desire to be helpful."

* * *

"The young ladies are very charming and kind and the managers go out of their way to be courteous. We intend to visit your exhibit again soon and until then many, many felicitations for the finest exhibit at the Golden Gate Exposition."

THE closing night reminded one of graduation day at school. Nine months had been spent by the personnel in close association, coöperating to build through the Exhibit a greater appreciation on the part of the public for the "Spirit of Service" which actuates the Bell System. After the last visitor had left, the personnel assembled in the Voder room for goodbyes. Our job was done and we were about to separate, to continue this same spirit on our regular assignments.

Amidst tears and laughter, N. R. Powley, President of The Pacific Telephone and Telegraph Company, which operated the Exhibit, expressed appreciation to the personnel for their splendid achievement. Telegrams of commendation from Walter S. Gifford, President of the American Telephone and Telegraph Company; A. W. Page, Vice President of the American Telephone and Telegraph Company; and John Mills, Director of Publication of the Bell Telephone Laboratories, were read.

There is no better way to summarize the accomplishments of the Exhibit than to quote the message from Mr. Gifford:

"I want to express to you and your associates my congratulations and thanks for the splendid way with which you have handled the Bell System Exhibit. Its outstanding success has been a great satisfaction to us all."

THE QUARTERLY IN NEW DRESS

THE changes which are evident in the format and typography of this issue of the BELL TELEPHONE QUARTERLY have been made in the interests of easier reading and more pleasing appearance. Its editorial policy, of serving the Bell System as "a medium of suggestion and a record of progress," remains unchanged.

CONTRIBUTORS TO THIS ISSUE

The degrees of B.A., A.M., and B.S. were conferred on John Mills by, respectively, the University of Chicago in 1901, the University of Nebraska in 1903, and Massachusetts Institute of Technology in 1909. The intervening years he occupied in study, and in teaching at those and other institutions of learning. In 1911 he joined the Engineering Department of the A. T. and T. Company. In 1915 he transferred to the Research Group in the Engineering Department of the Western Electric Company. From 1921 to 1925 he served as assistant personnel director and personnel director for the Engineering Department. With the incorporation of the Bell Telephone Laboratories in 1925, he was made Director of Publication, which office he now holds. In addition to numerous textbooks on scientific subjects, he is the author of "A Fugue in Cycles and Bels" and "Signals and Speech in Electrical Communication."

After attending Washington University, St. Louis, Mo., Horace H. Nance joined the St. Louis staff of the Long Lines Department of the A. T. and T. Company in 1910 as equipment attendant. In 1916 he went to Denver as district plant chief, and two years later was transferred to Washington, D. C. After absence in military service, he rejoined the Long Lines Department as a technical employee in New York. In 1919 he was appointed division superintendent of equipment construction at Chicago. A year later he was made division plant engineer in Atlanta, and in 1922 was transferred to Philadelphia in the same capacity. He was made Engineer of Transmission in New York in 1924, and in 1928 was appointed to his present post of Plant Extension Engineer.

Stevens Institute of Technology graduated Robert M. Oram with the degree of B.S. in M.E. in 1913. The following year he joined the Long Lines Department of the A. T. and T. Company. Two years later he resigned, but after war service and private occupation he rejoined the Long Lines Department in 1919. Until 1925 he held various plant engineering assignments in New York. He was then division transmission engineer, division outside plant engineer, division supervisor of cable construction, and division construction superintendent, in New York. Transferred to Philadelphia, he was division plant engineer and division plant superintendent there from 1928 to 1936. In the latter year he returned to New York as General Plant Supervisor, his present position.

It was in 1904 that Frank B. Jewett left the teaching staff of Massachusetts Institute of Technology to join the Engineering Department of the A. T. and T. Company. He had been graduated from Throop Polytechnic Institute (now California Institute of Technology) with the B.A. degree in 1898, and had received his Ph.D. degree from the University of Chicago in 1902. From 1908 to 1912 he was transmission and protection engineer of the A. T. & T. Co. In the latter year he was transferred to the Western Electric Co. as Assistant Chief Engineer, and became Chief Engineer of the company in 1916 and Vice President in 1922. In 1925 he was elected Vice President of the A. T. & T. Co., and in the same year was made President of Bell Telephone Laboratories Inc.—which offices he now holds. He was awarded the Distinguished Service Medal for his work during the World War; has received a number of honorary degrees, medals, and awards; and is active in numerous educational and scientific organizations. Last April he was elected President of the National Academy of Sciences.

Graduated from Bowdoin College with the B.A. degree in 1910, Thomas W. Williams was employed in the traffic department of the New England Telephone and Telegraph Company the same year. Six years later he transferred to the Traffic Department of the Long Lines Department of the A. T. and T. Company. From 1920 to 1929 he was with the Traffic Department of the New York Telephone Company, and in the latter year transferred to the Commercial Department. In 1938 he was appointed Director of the Bell System Exhibit at the New York World's Fair.

Entering the Pacific Telephone and Telegraph Company in 1908, **Laurence N. Roberts** was engaged in Plant Department work until 1915. Attendance at the University of Nevada, and military service, then occupied him for four years. He rejoined the Pacific Company in 1919, and until 1936 was employed in the Plant and Commercial Departments. In the latter year he was made Educational Supervisor, and in 1938 was appointed Manager of the Bell System Exhibit at the Golden Gate International Exposition.

FOR THE RECORD

C. G. STOLL SUCCEEDS E. S. BLOOM AS WESTERN ELECTRIC HEAD

Edgar S. Bloom retired as President of the Western Electric Company on December 31. Elected as his successor was Clarence G. Stoll, who since 1928 has been Vice President in charge of Operations.

Mr. Bloom's retirement brings to a close a distinguished telephone career. Upon receiving a post-graduate degree in mechanical engineering from the University of Pennsylvania in 1896, he started as a traffic inspector with the Metropolitan Telephone and Telegraph Company, predecessor of the New York Telephone Company. Within ten years he was Plant Superintendent of the New York and New Jersey Telephone Company. Three years later he moved to the Pacific Telephone and Telegraph Company in a similar capacity, and in 1910 was placed in charge of plant operations for the A. T. and T. Company. Two years later he was made Operating Vice President of a group of Bell companies in the Southwest. Appointed receiver for the Central Union Telephone Company at Chicago in 1914, he brought about a successful reorganization and later became President of the Ohio and Indiana Bell Telephone Companies and Vice President of the Illinois Bell Telephone Company. In 1922 Mr. Bloom came to New York as Vice President of the A. T. & T. Co. In 1926 he was elected President of the Western Electric Company.

Mr. Stoll graduated from Penn State in 1903 and entered Western Electric's student training course in Chicago. By 1908 he had become Engineer of Methods and later head of the manufacturing branch in New York. Summoned abroad in 1912, he acted as shop superintendent in the company's Antwerp factory until the World War forced the shop to close. Returning to the United States, he rose through various supervisory posts in manufacturing and technical operations at the Hawthorne Works in Chicago and in 1923 was placed in charge of the Works. He came to New York three years later and was elected Vice President in charge of Manufacturing and a director of the company. Since 1928 he has been Vice President in charge of Operations.

BELL TELEPHONE QUARTERLY

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BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

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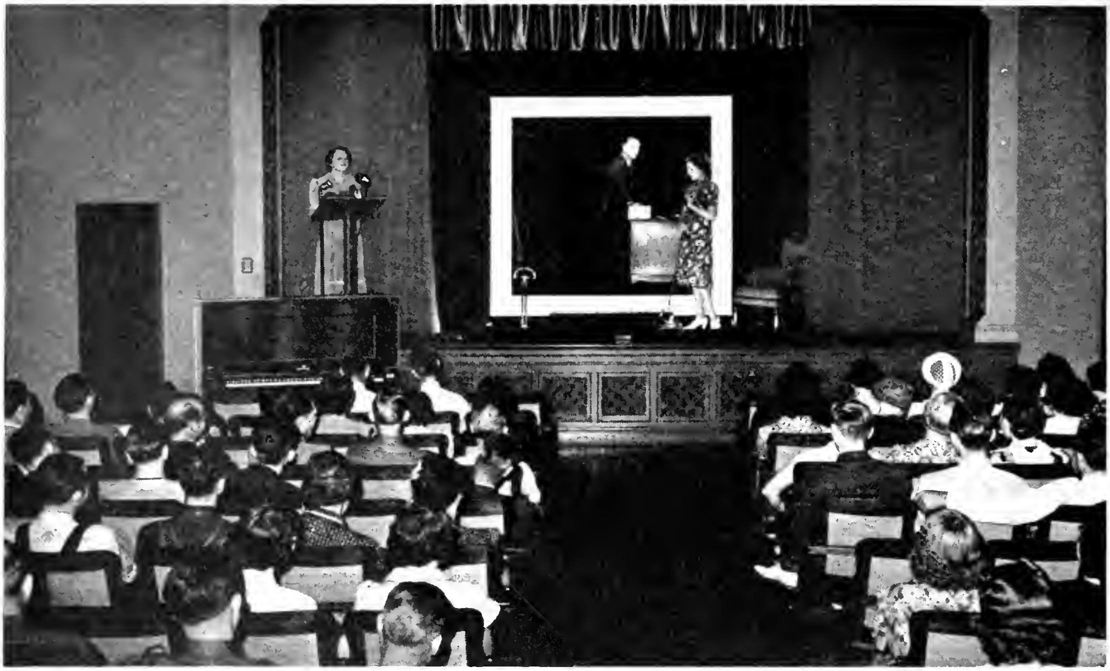


SERVICE IN THE MIRROR

Within the gilt frame and against a black back-drop, faulty and pleasing actions, attitudes, and expressions of employees are "mirrored" to an audience here consisting of members of the Commercial, Plant, and Traffic Departments. The characters represented on stage in this picture are an installer and a housewife: the narrator, at the left, lays the scene for each incident. Employees throughout the country have taken part in similar "service skits," the objectives of which are described in the article beginning on the opposite page.

TOWARD A MORE PLEASING SERVICE

The Human Touch in Dealing with Customers, the Exercize of Judgment and Initiative in Unusual Situations, Help to Express the System's Attitude to the Public

By HAROLD M. PRESCOTT

The ideal of a friendly, personal telephone service, as pleasing as it is efficient, has been a fundamental concept of Bell System operations for years.

As far back as 1922, President Thayer emphasized it by stating, "A really satisfactory service, besides being technically good, must include that intangible quality which we call the spirit of service pervading the whole personnel through all contacts with the public we serve."

President Gifford has similarly stressed and amplified the idea in frequent public statements, as well as in addresses to groups of Bell System executives and department heads. In his report to stockholders on Bell System operations for 1939 is the following reiteration of the concept: "In aiming to give the best possible telephone service, continued emphasis has been placed on the importance of such intangible but very real elements as courtesy, the spirit of helpfulness, the consideration of the needs of the individual subscriber and the use of initiative where regular practices are not adequate because of special circumstances."

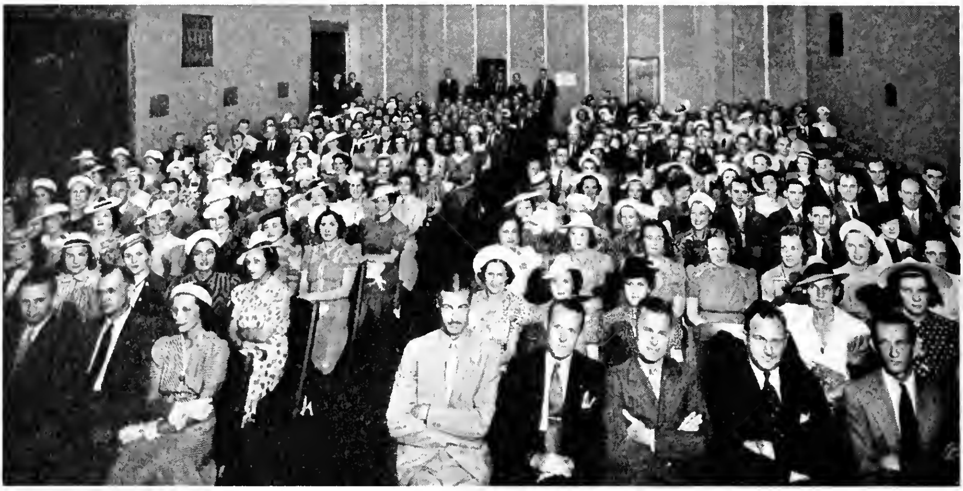
Thus, the ideal has long been recognized; but the difficulty has been to define it practically to the great body of employees through whose attitudes and actions it must, in the final analysis, find expression. Only in the last few years has the ideal begun to mature fully, and it is the purpose of this article to outline the problem, and the methods by which this impressive change is being brought about.

It is difficult to define satisfactorily just what is meant when we speak of personalizing the service. One Bell Company has effectively consolidated the thoughts of many and expressed it thus:

"Courteous, businesslike, interested and natural treatment of customers in every contact with them."

"Willingness to grant reasonable requests even though they are not provided for in the rules and practices."

"Using routines and specifications as a guide to the handling of routine matters—not substituting them for judgment and common sense when unusual situations arise."



TYPICAL AUDIENCE

More than 125,000 telephone people, from all departments, attended "service skit" performances during 1939

"Breaking away from too close adherence to set practices and phrases when need develops."

"Being natural and pleasant in all dealings with people."

"Being patient, sympathetic, willing to listen, eager to understand and to help."

"Handling each contact with the customer in such a friendly manner that he will like the employee and the Company."

System Objectives and Program

SUCH a service, individually pleasing, cannot be brought about by written instructions and routines. It cannot be obtained by formula. It implies freedom to give expression to the natural tendency of all Bell System employees to be friendly and pleasant. It also implies certain limitations on the impulsive and indiscriminate use of judgment in all situations which might arise. Obviously, however, it cannot be limited by numerous restrictions without destroying the employee initiative and spontaneous action which are so necessary to its accomplishment. It can only be obtained by first developing in each employee a thorough understanding of the aims and objectives of the business.

Since each employee has the sincere desire to give such a service, his or her own judgment—in the light of that understanding—will then establish its own restrictions, suggest the occasions and opportunities, tell when to act, and how far to go. Some employees will visualize and understand the objectives more quickly than others. Not all will detect the same possibilities. But each will discover the means of expressing his or her own personality in the rendering of a more friendly and personal service.

All of the Bell System Companies have been and are now conducting

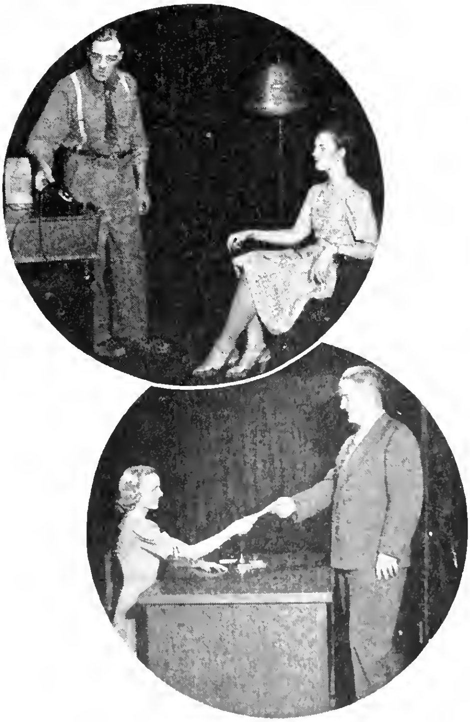
SPOTLIGHT ON PLEASING SERVICE

A friendly, interested attitude is demonstrated by (top to bottom) a repair service clerk, a supervisor and operator, an installer, and a business office representative

well planned programs for attaining the desired results. And throughout this effort one fact has been apparent—that leadership by executive management in this approach is of primary importance. Pleasing service will not just happen, any more than will high-grade technical results be attained, unless employees have a clear understanding of the objectives and how to reach them.

The acquainting of employees in all departments with a fundamental knowledge of Company aims and policies constitutes one of the more important activities. The better an employee understands his Company, the better he or she will be able to represent it to the public. The subjects covered in this educational program include Company organization, finances, working conditions, methods, practices, problems, service, operating results, and other significant matters.

The first step in such a program, logically, is the development of a proper understanding among the supervisory forces, who can then aid in reaching all employee levels with full and accurate information. Policies and objectives are discussed, questions asked and answered, and the reasons behind methods and practices are explained. This activity is then broadened to include employee information courses; employee infor-



Uncertain Abrupt Routine Irritated Custome

INDIFFERENT SERVICE

"Before and After Taking" might be the title for the story told by the facial expressions in the pictures above and on the opposite page

mation bulletins; group discussions with employees, either scheduled or informal; group meetings, pamphlets, and bulletins especially prepared for new employees; and casual, everyday, on-the-job encounters.

It is apparent that employees cannot be permitted to exercise judgment and freedom in dealing with customers until they have obtained a clear understanding of what constitutes good personalized service. Simply having the desire to render a pleasing and personal service is not enough. Activities directed specifically toward developing the right viewpoint include:

Increased emphasis in training programs on the principles of pleasing tone, voice, and manner.

Having groups of supervisory employees listen in simultaneously on operators' work, after which all members of the group discuss what has been heard, and reach a common understanding in regard to their individual appraisals of the service, tone, and manner.

Encouraging all levels of management to use every opportunity to observe the service, tone and manner, followed by a discussion with the force of what was observed.

Preparation and study of case examples of the handling of actual contacts between employees and customers. The tone and manner used by the employee in the handling of the case is compared with what might have been a more pleasing treatment of the situation.

Use of test cases in which a situation is presented, and the employees describe the best procedures, in their judgment, for dealing with the condition.

Employment of all contacts between supervisory force and employees in the day-to-day work for creating the proper viewpoint in regard to personalized service.

Analyses of service criticisms and customer attitude surveys.

An activity aptly described as "Hear yourselves as others hear you" has been introduced in several Companies with beneficial results.

Confident Courteous Sparkling Pleased Customer

PLEASING SERVICE

In the Traffic Department application of this plan, each operating employee is permitted to listen in on other operators and appraise the service from the viewpoint of the customer. The observing is usually done in groups, and frequently with a supervisory employee also participating. Particular situations are pointed out and discussed as they occur. Further discussion is held after the listening period is concluded, so as to bring out how any undesirable occurrences could have been avoided and the service improved from the standpoint of the customer.

Suggestions are invited, and the employees are encouraged to adopt in their own work the principles developed during the listening and discussion. In subsequent discussions the employees are encouraged to relate how they have been able to apply to their own work what they learned by their listening-in experience. Criticisms of established practices are welcomed and, whenever practicable, modifications or changes are made and the employee concerned informed of this.

Attention to the *principles* governing the determination of practices, rather than to the precise rules given in the practices, brings about such evidences of a desire to render a pleasing and personal service as the following:

All telephone dealings with customers are carried on in a friendly and natural manner, as if conversing face to face.

Suggested phrases are merely examples of a good way to express a thought concisely, and not rigid expressions to be memorized and repeated precisely. The attitude is direct and informal rather than impersonal and formally precise. For example, "I'm sorry" is more natural than "I am sorry" and "Do you know the number?" is more personal than "What is the number, please."

The words used are those which readily occur as the natural expression of thoughts in the interchange of ideas with the customer. The choice of words and manner are adapted to the individual customer and to the condition arising. For example, different words and manner of speaking are used in dealing with children than with adults. The

"I help provide your telephone service"

"My job of splicing cable is important because it is necessary to your telephone service. In the telephone business, there are many different jobs but all of us have the same aim—to do our work so that your service will be fast, dependable, low in cost and pleasing to you in every way."

Your Telephone Cable Splicer

You are cordially invited to visit the Bell System exhibit when you attend the New York and San Francisco World's Fairs.

TELLING OUR CUSTOMERS

Some of the Associated Bell Companies have used the theme of Pleasing Service as part of their regular newspaper advertising programs

wording of a statement is altered when repeating something that was not understood the first time it was spoken.

The use of routine or inappropriate phrases which do not quite apply is avoided: for example, the thoughtless use of "Thank you" to acknowledge a request such as "Will you see if the line is still busy?"

The natural tone and pitch characteristics of the voice are retained. Unnatural voice habits are avoided, such as mechanical voice tone, extreme rising inflection, exaggeratedly sweet tone, precise diction, and other voice mannerisms which may be distracting or displeasing to the customer.

Customers' wishes are conformed with whenever possible, so far as is consistent with the intent of the Company's objectives and the rights of any other customers who may be involved. Not infrequently it is found possible to give greater assistance than the customer expects.

The operator is attentive to the customer at all times and gives undivided attention to his call; unavoidable and long waits are explained; all remarks or orders are acknowledged; customers are addressed by name personally if the name is known; a friendly and pleasant response is made to all friendly greetings. Regret is expressed when something happens,

You have a personal representative in the telephone office

You may never meet her but she's there—the young woman who has at her fingertips a record of your telephone service. When you telephone our business office, she will handle any changes you want in your service, take care of your listings in the directory, and give you information you may want about your account.

She is eager to help you—to give you prompt, courteous, pleasing service. She seeks to do this with understanding—in the manner of a friend.

It takes telephone workers in many kinds of jobs to provide your telephone service. Whatever the job, they strive constantly to furnish service that meets your personal needs and is pleasing to you in every way.

• • •

NORTHWESTERN BELL TELEPHONE COMPANY

but mechanical and insincere expressions of regret are avoided. Excessive use of "I'm sorry," and the too frequent use of such expressions as "please" and "thank you," give the impression of studied formality rather than of friendly personal communication.

Undue haste or impatience is avoided, such as by talking in a hurried manner, breaking in to interrupt or to request a repetition before the customer has had time to finish what he has started to say, or trying to hurry him along when he hesitates or speaks slowly.

Employees are alert to recognize immediately and give individual attention to unusual situations, such as a call on which it appears that difficulty has been experienced, or where the customer's manner indicates that the call is urgent. Constant vigilance is kept for signs that indicate that the customer may be having difficulty, even though the trouble was not reported.

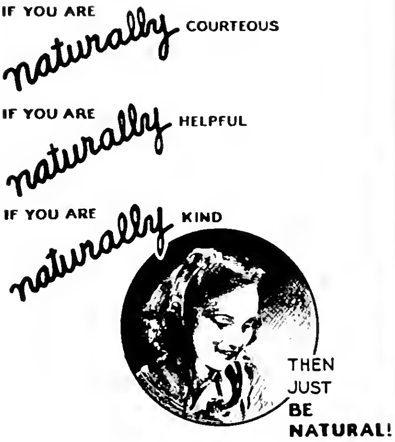
REMINDING OURSELVES

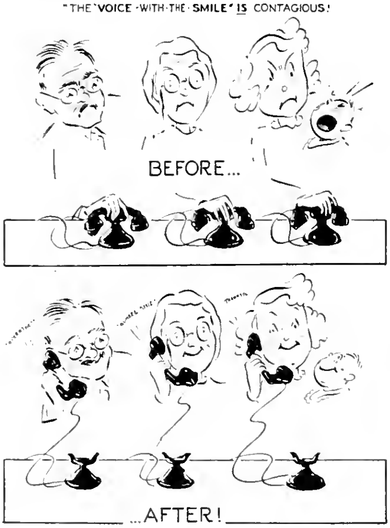
Examples of Pleasing Service are frequently noted in Associated Company employee publications—where these pictures of installer (above) and P.B.X. repairman (below) appeared

Dramatizing a Personalized Service

THE use of service skits, which dramatize the contrast between a technically good service and an equally good but personalized service, is one of the most effective means of demonstrating to the personnel some of the more important phases of friendly service. Interest is stimulated by encouraging as many employees as possible to participate.

While the service skit idea is not a recent one, it received new impetus at a meeting of the System vice presidents and general managers in 1937, where Plant and Sales skits were presented, and from a series of skits which was shown to the general traffic managers of the System in 1938.





REMINDERS

Posters are widely used. In almost all cases they represent the talent of employees—as do those above. The initials "C & P" at the right have added meaning for members of the Chesapeake and Potomac Telephone Company

The leader in the Traffic skits introduced them with the following comment: "We will try to show you a variety of typical transactions with customers, based on actual experiences of local, toll or information operators. Each case will first appear in a way which shows the operator usually following her instructions, yet producing a neutral or negative impression on the customer and sometimes even failing to render desired, available service. Then, the same operator will handle the case again but in a way which leaves with the customer an impression of alertness and interest in his needs, and yields him a more satisfying service in every respect."

FOLLOWING this conference demonstration, the same cast presented the skits before officials and employees of many companies, and soon this "See yourself as others see you" idea was taken over and developed in all of the operating departments by the Associated Companies. It aroused tremendous interest among Commercial, Plant and Traffic employees. During 1939 more than 300 employee groups were formed to carry on this type of activity. More than 2000 employees participated in these "shows" and more than 125,000 people saw them. Not included in these figures are skits put on for the information of officials and employees of other telephone companies whose lines connect with those of Bell System companies.

In cities where dramatization of the skits by local employee casts is impractical, other methods of presenting them are used, thus extending the advantages of this important activity to even the smallest offices. Such methods include the recording of the skits on phonograph records; the reading and impromptu dramatization of the dialogue by two or more employees; the discussion of skit dialogue between unit supervisors, chief operators, and individual employees, with emphasis on the difference in the impressions of the service the customer would receive under the two types of handling.

Service skits illustrate the opportunities for personalizing the service which are to be found in everyday telephone transactions. Typical skits include a demonstration of friendly interested tone of voice; telephone habits and mannerisms; choice of words; repetitions and interruptions; impersonal, uninterested attitude; recognition of unusual circumstances and of opportunities to be helpful. They provide perhaps the best way of bringing vitality, understanding, and enthusiasm to the front in connection with continuing efforts for service betterment.

THE marked improvement in the technical phases of telephone service during the past ten years has left less room for improvements in this field than there has been in the past. While further technical advances will continue to be made, the greatest immediate opportunity for service betterment lies in the broad field of making the service more pleasing and more personal for the customer.

Vice President W. H. Harrison, of the A. T. and T. Company, has expressed the objective in these words: "More attentiveness, more courtesy, more helpfulness—those personal touches which make the subscriber feel he is dealing with an individual and with an organization whose desire first and last is to serve his every request. It is not a challenge of leadership in technical proficiency; it is a challenge of stimulation, of inspiration to departmental leadership to create and sustain the will to do in this activity throughout every level of supervision."

When the men and women in the organization are satisfied that they are fully using these principles in their contacts with the public, then the Bell System as an organization will be giving a truly pleasing service.

THE SIXTEENTH DECENNIAL CENSUS

Some Observations, in Advance, on the Six Different Enumerations Which Comprise the Whole Undertaking and on the Usefulness of the Resultant Statistical Data to the Telephone Business

By ROBERT L. TOMBLEN

This is a census year. Some 12,000 enumerators started on January 2 to gather information with respect to the three million commercial firms, 170,000 manufacturing establishments, and approximately 12,000 mines and quarries in the country. This phase of the general census will take about five months to complete. During the month of April about 120,000 field workers will conduct an enumeration of a population estimated to have reached 131 million, a housing census to record the characteristics of about 33 million dwellings, and an agricultural census covering about seven million farms. Thus the sixteenth decennial census is actually six censuses combined into one major undertaking. This represents a gradual development of census procedure since the first enumeration of population 150 years ago.

The Constitution of the United States provides for an enumeration of the population every ten years for the purpose of apportioning Congressional representation and direct taxes. The only classification called for in the original authorization was a distinction between free persons and slaves. However, the number of heads of families was actually reported in 1790, so that even the first census exceeded the constitutional requirements slightly. Since then the population schedule has expanded far beyond its original scope.

In the preparation of the various census schedules, several thousand questions were suggested for inclusion by interested organizations and individuals. The final questionnaires evolved from a long series of conferences with experts in each field of inquiry and include the most significant and practical items, representing a very small fraction of the total proposals. Several new questions, designed to cover changed conditions since 1930, survived the elimination process. On the other hand, some of the questions included in the census schedules for past decades will be dropped this year as being no longer significant.

The complete census is expected to provide the factual background for a comprehensive statistical inventory of the nation's population, its living conditions, resources, and business activities. Much of this information should have considerable value to business men, market analysts, statisticians, and the like.

The telephone industry has always made rather extensive use of census statistics in connection with market forecasts and measurements of sales results, and it is awaiting with interest the results of the 1940 census. But many persons, both inside and outside the telephone business, have little knowledge regarding the real nature and scope of the tremendous task of census taking, and few are informed concerning the factual data to be collected this year. Perhaps some of those who will have been questioned by the enumerator before this appears in print may feel that they have acquired more than an academic knowledge of the census as a result of their experience.

Difficulties Which are Inherent in Census Enumerations

While the Census Bureau has grown rapidly, the country feels that it has always given full value for the money spent on its activities. It has operated efficiently, and has acquired a reputation for accuracy even beyond its own claims. When censuses have fallen short of a high standard, it has been because the Bureau was handicapped by factors beyond its control.

In several important respects—date of the census, scope of the questionnaires, and selection of supervisors and enumerators—the Census Bureau has perhaps made concessions at times to meet the desires of particular groups. Nevertheless, until the present time the Bureau has had a rather free hand in designing schedules; but serious question now is being raised in some quarters as to its constitutional right to ask for certain information.

There are other inevitable difficulties in census taking for which the Census Bureau cannot be held responsible. Instructions to enumerators and definitions of terms are subject to different interpretations; the phrasing of some questions may prove to be ambiguous or misunderstood; most interviews are with housewives, many of whom cannot give the requisite information; and last—but by no means least—is the difficulty introduced by certain queries which have been criticized as invading the privacy of the home and infringing on personal rights.

There is considerable opposition, for one reason or another, to questions relative to personal income, value of property, mortgage financing, and whether a woman has been married more than once. In cases where this resentful attitude is pronounced, it is possible that individuals may either deliberately misrepresent the facts in their responses or refuse to answer such questions. Any considerable amount of this type of reaction, if it should develop, would tend to cast doubt on the reliability and consequent usefulness of many tabulations. A census is no better than the information received, and its value depends upon the ability and willingness of the individual citizen to give full and accurate replies to all questions. No exact conclusions can be drawn from data of questionable validity.

A practical example of the difficulties encountered in attempting to collect field data arose in connection with the Real Property Inventories taken in many cities six or seven years ago. The replies received from householders indicated such a lack of information regarding property values and such a degree of misstatement with respect to these values that careful analysis showed the results in some cases to be questionable as a measure of true values.

This sixteenth decennial census is too complex and extensive to permit a complete description in a short review, but the principal phases of general interest will be briefly outlined.

The Census of Population

FOR the population census the 529 census districts have been subdivided into 147,000 enumeration districts, each containing some 1,500 persons or less. Usually there will be one enumerator for each district, except in certain regions where one will cover several districts. Incidentally, it is stated on each census form that enumerators are sworn to secrecy and that the data they collect can be used only for compiling statistical reports, and not for purposes of taxation, regulation, or investigation.

A reproduction of the population schedule appears opposite page 100. Perhaps the most fundamental innovation in it is the inclusion of a supplementary set of questions which will be asked of five per cent of the population. This sample is arbitrarily composed of the persons who appear on the fourteenth and twenty-ninth lines of each sheet of the schedule. Since, among other reasons, the majority of the extra queries apply to adults—principally wage earners and housewives—it seems doubtful if this random sampling will be representative of the population as a whole, and the results should be interpreted in the light of this situation.

In addition to the ordinary questions about age, sex, race, marital status, place of birth, relationship to head of household, size of family, and citizenship of the foreign-born, important new statistical information will also be accumulated on education, migration, employment status, and personal income. Some doubt has been expressed as to whether the data reported for the last item will provide an accurate picture of the situation with respect to income.

ONE of the most interesting of the new questions is that regarding the highest grade in school completed by each individual. Perhaps, as some people believe, the replies to this question will indicate the reasons for some of the pronounced differences in buying habits in different communities. Certainly it will have more significance than the former and now discarded question about literacy. Twenty years ago, six per cent of the population ten years of age and over could not read and write English, but it is believed that this ratio has now fallen to about two per cent, and will disappear rapidly as the older immigrants pass out of the population through death.

In this connection, it is of interest that the year of immigration of the foreign-born, quite important in the past, is now dropped. Immigration in recent years has been negligible (indeed, between 1930 and 1940 there was a net outward migration) and consequently the foreign-born population is declining rapidly in numbers, the death rates of this class being high because of the advanced age of many of them. Conversely, the native-white population is becoming a much larger percentage of the total market than formerly, a condition which has always been regarded as favorable to telephone growth.

ANOTHER innovation on the population schedule is the special effort which is called for to insure that all infants will be reported. The purpose is to overcome the alleged tendency toward under-enumeration of very young children. The enumerator must inquire in each household if any babies were born to any member during the four months ending March 31, 1940. A special Infant Card must be filled out for each such child still living with the household, in addition to the entry made on the population schedule.

The Infant Card will have advantages beyond the improvement of the enumeration. Included in the information secured will be the place of birth. A check against the birth and infant death certificates will furnish an index of the completeness of birth registration, as well as of any possible under-enumeration of children under four months of age. In this connection it might be noted that the census population figures will provide a new base for computing current birth and death rates and will also facilitate the revision of yearly rates from 1930 to date.

Aside from the one exception just mentioned, the very useful enumeration by ages will remain unchanged. The results will be interesting to study because the changing age composition of the population is an important factor in market considerations. As a result of the lower birth rates of the past decade, the adults now form a larger proportion of the total population than in 1930. This in turn has resulted in a relatively faster growth in the number of families than in population during this ten-year period, a development favorable to the telephone industry since the family represents the basic unit of residential telephone use.

A new approach has been made to the collection of data on employment and unemployment. For the first time, information will be obtained on the economic activity of every person 14 or more years of age for a definite period (the week of March 24–30). The census schedule distinguishes between workers in private occupations or permanent Government occupations and those in public emergency or temporary work, such as relief projects. Persons seeking work will be divided between those with previous work experience and new workers. Persons not in the labor force will be classified as engaged in home housework, in school, unable to work, or "other."

The number of hours worked will be reported for persons at work during the last week in March, and the duration of unemployment will be stated for those seeking work and for emergency workers. For persons employed during the specified week, or those with a job or a business, ques-

ty, from your census reports. Only sworn census employees will see your statements. Data
. Your Census Reports Cannot Be Used for Purposes of Taxation, Regulation, or Investigation.

16-252

U OF THE CENSUS

Sta ITED STATES: 1940

Co EDULE

U. S

S. D. No. .... E. D. No. ....

Enumerated by me on ...., 1940.

Sheet N .

.... A

...., *Enumerator.*

PERSONS 14 YEARS OLD AND OVER—EMPLOYMENT STATUS

	If at private or nonemergency Government work. ("Yes" in Col. 21)	If seeking work or assigned to public emergency work. ("Yes" in Col. 22 or 23)	OCCUPATION, INDUSTRY, AND CLASS OF WORKER For a person *at work, assigned to public emergency work, or with a job* ("Yes" in Col. 21, 22, or 24), enter *present occupation*, industry, and class of worker. For a person *seeking work* ("Yes" in Col. 23): (a) If he has previous work experience, enter *last occupation*, industry, and class of worker; or (b) if he does not have previous work experience, enter "New worker" in Col. 28, and leave Cols. 29 and 30 blank.					INCOME IN 1939 (12 months ending December 31, 1939)			
Line No.	Number of hours worked during week of March 24-30, 1940	Duration of unemployment up to March 30, 1940—in weeks	OCCUPATION Trade, profession, or particular kind of work, as— *frame spinner* *salesman* *laborer* *rivet heater* *music teacher*	INDUSTRY Industry or business, as— *cotton mill* *retail grocery* *farm* *shipyard* *public school*	Class of worker	CODE (Leave blank)	Number of weeks worked in 1939 (Equivalent full-time weeks)	Amount of money wages or salary received (including commissions)	Did this person receive income of $50 or more from sources other than money wages or salary? (Yes or No)	Number of Farm Schedule	Line No.
	26	27	28	29	30	F	31	32	33	34	
1											1
2											2
3											3
4											4
5											5
6											6
7											7
8											8
9											9
10											10
11											11
12											12
13											13
14											**14**
15											15
16											
39											39
40											40

	WOMEN WHO ARE E BEEN MARRIED		FOR OFFICE USE ONLY—DO NOT WRITE IN THESE COLUMNS																	
Line No.	Age at first marriage	Number of children ever born (Do not include stillbirths)	Ten (4)	V-R (5)	Fm. res. and Sex (6 and 9)	Color and nat. (10, 15, 36, and 37)	Age (11)	Mar. st. (12)	Gr. com. (B)	Cit. (16)	Wrk. st. (E)	Hrs. wkd. or Dur. un. (26 or 27)	Occupation, industry, and class of worker (F)	Wks. wkd. (31)	Wages (32)	Ot. inc. (33)			Line No.
	49	50	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
14																			**14**
29																			**29**

Your report is required by Act of Congress. This Act makes it unlawful for the Bureau to disclose any facts, including names or identity, from your census reports. Only sworn census employees will see your statements. Data collected will be used solely for preparing statistical information concerning the Nation's population, resources, and business activities. Your Census Reports Cannot Be Used for Purposes of Taxation, Regulation, or Investigation.

16-252

DEPARTMENT OF COMMERCE—BUREAU OF THE CENSUS

SIXTEENTH CENSUS OF THE UNITED STATES: 1940

POPULATION SCHEDULE

State ....

County ....

Incorporated place ....

Township or other division of county ....

Ward of city ....

Block Nos. ....

Unincorporated place .... (Name of unincorporated place having 100 or more inhabitants)

Institution .... (Name of institution and lines on which entries are made)

S. D. No. .... E. D. No. ....

Enumerated by me on ...., 1940.

............, Enumerator.

Sheet No. .... A

U. S. GOVERNMENT PRINTING OFFICE 16—11576

	LOCATION		HOUSEHOLD DATA				NAME	RELATION		PERSONAL DESCRIPTION				EDUCATION			PLACE OF BIRTH		CITIZENSHIP	RESIDENCE, APRIL 1, 1935					PERSONS 14 YEARS OLD AND OVER—EMPLOYMENT STATUS																
																				IN WHAT PLACE DID THIS PERSON LIVE ON APRIL 1, 1935? For a person who, on April 1, 1935, was living in the same house as at present, enter in Col. 17 "Same house," and for one living in a different house but in the same city or town, enter, "Same place," leaving Cols. 18, 19, and 20 blank, in both instances. For a person who lived in a different place, enter city or town, county, and State, as directed in the Instructions. (Enter actual place of residence, which may differ from mail address.)							If neither at work nor assigned to public emergency work ("No" in Cols. 21 and 22)		For persons answering "No" to questions 21, 22, 23, and 24		If at private or nonemergency Government work ("Yes" in Col. 21)	If seeking work or assigned to public emergency work ("Yes" in Col. 22 or 23)	OCCUPATION, INDUSTRY, AND CLASS OF WORKER For a person *at work, assigned to public emergency work, or with a job* ("Yes" in Col. 21, 22, or 24), enter *present occupation*, industry, and class of worker. For a person *seeking work* ("Yes" in Col. 23): (a) If he has previous work experience, enter *last occupation*, industry, and class of worker; or (b) if he does not have previous work experience, enter "New worker" in Col. 28, and leave Cols. 29 and 30 blank.					INCOME IN 1939 (12 months ending December 31, 1939)			
Line No.	Street, avenue, road, etc.	House number (in cities and towns)	Number of household in order of visitation	Home owned (O) or rented (R)	Value of home, if owned, or monthly rental, if rented	Does this household live on a farm? (Yes or No)	Name of each person whose *usual place of residence* on April 1, 1940, was in this household. BE SURE TO INCLUDE: 1. Persons temporarily absent from household. Write "Ab" after names of such persons. 2. Children under 1 year of age. Write "Infant" if child has not been given a first name. Enter ⓧ after name of person furnishing information	Relationship of this person to the head of the household, as wife, daughter, father, mother-in-law, grandson, lodger, lodger's wife, servant, hired hand, etc.	CODE (Leave blank)	Sex—Male (M), Female (F)	Color or race	Age at last birthday	Marital status—Single (S), Married (M), Widowed (Wd), Divorced (D)	Attended school or college any time since March 1, 1940? (Yes or No)	Highest grade of school completed	CODE (Leave blank)	If born in the United States, give State, Territory, or possession. If foreign born, give country in which birthplace was situated on January 1, 1937. Distinguish Canada-French from Canada-English and Irish Free State (Eire) from Northern Ireland.	CODE (Leave blank)	Citizenship of the foreign born	City, town, or village having 2,500 or more inhabitants. Enter "R" for all other places	COUNTY	STATE (or Territory or foreign country)	On a farm? (Yes or No)	CODE (Leave blank)	Was this person AT WORK for pay or profit in private or nonemergency Govt. work during week of March 24–30? (Yes or No)	If not, was he at work on, or assigned to, public EMERGENCY WORK (WPA, NYA, CCC, etc.) during week of March 24–30? (Yes or No)	Was this person SEEKING WORK? (Yes or No)	If not seeking work, did he HAVE A JOB, business, etc.? (Yes or No)	Indicate whether engaged in home housework (H), in school (S), unable to work (U), or other (Ot)	CODE	Number of hours worked during week of March 24–30, 1940	Duration of unemployment up to March 30, 1940—in weeks	OCCUPATION Trade, profession, or particular kind of work, as— *frame spinner* *salesman* *laborer* *rivet heater* *music teacher*	INDUSTRY Industry or business, as— *cotton mill* *retail grocery* *farm* *shipyard* *public school*	Class of worker	CODE (Leave blank)	Number of weeks worked in 1939 (Equivalent full-time weeks)	Amount of money wages or salary received (including commissions)	Did this person receive income of $50 or more from sources other than money wages or salary? (Yes or No)	Number of Farm Schedule	Line No.
	1	2	3	4	5	6		8	A	9	10	11	12	13	14	B	15	C	16	17	18	19	20	D	21	22	23	24	25	E	26	27	28	29	30	F	31	32	33	34	
1																																									1
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SUPPLEMENTARY QUESTIONS

For Persons Enumerated on Lines 14 and 29

		FOR PERSONS OF ALL AGES									FOR PERSONS 14 YEARS OLD AND OVER							FOR ALL WOMEN WHO ARE OR HAVE BEEN MARRIED			FOR OFFICE USE ONLY—DO NOT WRITE IN THESE COLUMNS																
		PLACE OF BIRTH OF FATHER AND MOTHER If born in the United States, give State, Territory, or possession. If foreign born, give country in which birthplace was situated on January 1, 1937. Distinguish Canada-French from Canada-English and Irish Free State (Eire) from Northern Ireland			MOTHER TONGUE (OR NATIVE LANGUAGE)		VETERANS Is this person a veteran of the United States military forces; or the wife, widow, or under-18-year-old child of a veteran?				SOCIAL SECURITY			USUAL OCCUPATION, INDUSTRY, AND CLASS OF WORKER Enter that occupation which the person regards as his usual occupation and at which he is physically able to work. If the person is unable to determine this, enter that occupation at which he has worked longest during the past 10 years and at which he is physically able to work. Enter also usual industry and usual class of worker. For a person without previous work experience, enter "None" in Col. 45 and leave Cols. 46 and 47 blank																							
Line No.	NAME	FATHER	MOTHER	CODE (Leave blank)	Language spoken in home in earliest childhood	CODE (Leave blank)	If so, enter "Yes"	If child, is veteran-father dead? (Yes or No)	War or military service	CODE (Leave blank)	Does this person have a Federal Social Security Number? (Yes or No)	Were deductions for Federal Old-Age Insurance or Railroad Retirement made from this person's wages or salary in 1939? (Yes or No)	If so, were deductions made from (1) all, (2) one-half or more, (3) part, but less than half, of wages or salary?	USUAL OCCUPATION	USUAL INDUSTRY	Usual class of worker	CODE (Leave blank)	Has this woman been married more than once? (Yes or No)	Age at first marriage	Number of children ever born (Do not include stillbirths)	Ten (4)	V R (5)	Fm res and Sex (6 and 9)	Color and nat (10, 16, 36, and 37)	Age (11)	Mar st (12)	Gr com (B)	Cit (16)	Wrk st (E)	Hrs wkd or Dur un (26 or 27)	Occupation, industry, and class of worker (F)	Wks wkd (31)	Wages (32)	Ot inc (33)			Line No.
	35	36	37	G	38	H	39	40	41	I	42	43	44	45	46	47	J	48	49	50	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
14																																					14
29																																					29

Your report is required by Act of Congress. This Act makes it unlawful for the Bureau to disclose any facts, including names or identity, from your census reports. Only sworn census employees will see your statements. Data collected will be used solely for preparing statistical information concerning the Nation's population, resources, and business activities. Your Census Reports Cannot Be Used for Purposes of Taxation, Regulation, or Investigation.

DEPARTMENT OF COMMERCE—BUREAU OF THE CENSUS

SIXTEENTH CENSUS OF THE UNITED STATES: 1940—HOUSING

OCCUPIED-DWELLING SCHEDULE

(To be used for dwelling units occupied by households enumerated on the Population Schedule)

State ....
Incorporated place ....
Ward of city ....
County ....
Township or other division of county ....
Unincorporated place .... (Name of unincorporated place having 100 or more inhabitants)

S. D. No. .... E. D. No. ....
Enumerated by me on ...., 1940
.................., Enumerator

SHEET NO. ... A

SECTION	I. LOCATION AND HOUSEHOLD DATA							II. CHARACTERISTICS OF STRUCTURE				
	1	2	3	4	5	6	7	8	9	10	11	12
1	No. of structure in order of visitation Dwelling unit No. within structure	Population Line No. .... Block No. .... Name of head .... Street and No. .... Apt. No. or location	Color or race of head White ☐1 Negro ☐2 All other ☐3	Number of persons in household	Live on a farm? Yes ☐1 No ☐0	Home tenure Owned ☐0 Rented ☐1	Value of home or monthly rental $........ Est. rent of owned nonfarm home $........	Type of structure in which this dwelling unit is located Structure without business — No. of units 1-family detached ☐V 1 family attached ☐0 2 family side-by-side ☐1 2 family other ☐2 3-or-more fam. struct. without bus. ...... Struct. with business ...... Other dwelling place	Originally built as. Resid. struct. same no. dwlg. units ☐1 Resid. struct. differ no. dwlg. units ☐2 Nonresid. struct. ☐3	Exterior material Wood ☐1 Brick ☐2 Stucco ☐3 Other ☐4	Structure in need of major repairs? Yes ☐1 No ☐0	Year originally built ... A
2	Struct. No. .. Dwelling unit No. ..	Population Line No. .... Block No. .... Name of head .... Street and No. .... Apt. No. or location	Color White ☐1 Negro ☐2 All other ☐3	Number of persons	On a farm? Yes ☐1 No ☐0	Tenure Owned ☐0 Rented ☐1	Value or rent $........ Est. rent owned nonfarm $	Type of structure Structure without business — No. of units 1-fam detach ☐V 1-fam attach ☐0 2-fam s-by-s ☐1 2-fam other ☐2 3-or-more no bus. ...... With bus ...... Oth. dwlg. place	Built as. Residential same ☐1 Residential differ ☐2 Non-residential ☐3	Exterior Wood ☐1 Brick ☐2 Stucco ☐3 Other ☐4	Major repairs? Yes ☐1 No ☐0	Year built A
3	Struct. No. .. Dwelling unit No. ..	Population Line No. .... Block No. .... Name of head .... Street and No. .... Apt. No. or location	Color White ☐1 Negro ☐2 All other ☐3	Number of persons	On a farm? Yes ☐1 No ☐0	Tenure Owned ☐0 Rented ☐1	Value or rent $........ Est. rent owned nonfarm $	Type of structure Structure without business — No. of units 1-fam detach ☐V 1-fam attach ☐0 2-fam s-by-s ☐1 2-fam other ☐2 3-or-more no bus. ...... With bus ...... Oth. dwlg. place	Built as. Residential same ☐1 Residential differ ☐2 Non-residential ☐3	Exterior Wood ☐1 Brick ☐2 Stucco ☐3 Other ☐4	Major repairs? Yes ☐1 No ☐0	Year built A
4	Struct. No. .. Dwelling unit No. ..	Population Line No. .... Block No. .... Name of head .... Street and No. .... Apt. No. or location	Color White ☐1 Negro ☐2 All other ☐3	Number of persons	On a farm? Yes ☐1 No ☐0	Tenure Owned ☐0 Rented ☐1	Value or rent $........ Est. rent owned nonfarm $	Type of structure Structure without business — No. of units 1-fam detach ☐V 1-fam attach ☐0 2-fam s-by-s ☐1 2-fam other ☐2 3-or-more no bus. ...... With bus ...... Oth. dwlg. place	Built as Residential same ☐1 Residential differ ☐2 Non-residential ☐3	Exterior Wood ☐1 Brick ☐2 Stucco ☐3 Other ☐4	Major repairs? Yes ☐1 No ☐0	Year built A
5	Struct. No. .. Dwelling unit No. ..	Population Line No. .... Block No. .... Name of head .... Street and No. .... Apt. No. or location	Color White ☐1 Negro ☐2 All other ☐3	Number of persons	On a farm? Yes ☐1 No ☐0	Tenure Owned ☐0 Rented ☐1	Value or rent $........ Est. rent owned nonfarm $	Type of structure Structure without business — No. of units 1-fam detach ☐V 1-fam attach ☐0 2-fam s-by-s ☐1 2-fam other ☐2 3-or-more no bus. ...... With bus ...... Oth. dwlg. place	Built as. Residential same ☐1 Residential differ ☐2 Non-residential ☐3	Exterior Wood ☐1 Brick ☐2 Stucco ☐3 Other ☐4	Major repairs? Yes ☐1 No ☐0	Year built A
6	Struct. No. .. Dwelling unit No. ..	Population Line No. .... Block No. .... Name of head .... Street and No. .... Apt. No. or location	Color White ☐1 Negro ☐2 All other ☐3	Number of persons	On a farm? Yes ☐1 No ☐0	Tenure Owned ☐0 Rented ☐1	Value or rent $........ Est. rent owned nonfarm $	Type of structure Structure without business — No. of units 1-fam detach ☐V 1-fam attach ☐0 2-fam s-by-s ☐1 2-fam other ☐2 3-or-more no bus. ...... With bus ...... Oth. dwlg. place	Built as: Residential same ☐1 Residential differ ☐2 Non-residential ☐3	Exterior Wood ☐1 Brick ☐2 Stucco ☐3 Other ☐4	Major repairs? Yes ☐1 No ☐0	Year built A
7	Struct. No. .. Dwelling unit No. ..	Population Line No. .... Block No. .... Name of head .... Street and No. .... Apt. No. or location	Color White ☐1 Negro ☐2 All other ☐3	Number of persons	On a farm? Yes ☐1 No ☐0	Tenure Owned ☐0 Rented ☐1	Value or rent $........ Est. rent owned nonfarm $	Type of structure Structure without business — No. of units 1-fam detach ☐V 1-fam attach ☐0 2-fam s-by-s ☐1 2-fam other ☐2 3-or-more no bus. ...... With bus ...... Oth. dwlg. place	Built as. Residential same ☐1 Residential differ ☐2 Non-residential ☐3	Exterior Wood ☐1 Brick ☐2 Stucco ☐3 Other ☐4	Major repairs? Yes ☐1 No ☐0	Year built A
8	Struct. No. .. Dwelling unit No. ..	Population Line No. .... Block No. .... Name of head .... Street and No. .... Apt. No. or location	Color White ☐1 Negro ☐2 All other ☐3	Number of persons	On a farm? Yes ☐1 No ☐0	Tenure Owned ☐0 Rented ☐1	Value or rent $........ Est. rent owned nonfarm $	Type of structure Structure without business — No. of units 1-fam detach ☐V 1-fam attach ☐0 2-fam s-by-s ☐1 2-fam other ☐2 3-or-more no bus. ...... With bus ...... Oth. dwlg. place	Built as: Residential same ☐1 Residential differ ☐2 Non-residential ☐3	Exterior Wood ☐1 Brick ☐2 Stucco ☐3 Other ☐4	Major repairs? Yes ☐1 No ☐0	Year built A
9	Struct. No.	Population Line No. .... Block No. .... Name of head	Color White ☐1 Negro	Number of persons	On a farm? Yes	Tenure Owned	Value or rent $........	Type of structure Structure without business — No. of units 1-fam detach ☐V 3-or-more no bus.	Built as. Residential same ☐1	Exterior Wood ☐1 Brick ☐2	Major repairs? Yes	Year built

SECTION	III. CHARACTERISTICS OF DWELLING UNIT										IV UTILITY DATA FOR EACH RENTER-OCCUPIED NONFARM UNIT	
	13	14	15	16	17	18	19	20	21	22	23	24
1	Number of rooms B	Water supply Running water in dwelling unit ☐1 Hand pump in dwelling unit ☐2 Running water within 50 ft. ☐3 Other supply within 50 ft. ☐4 No water supply within 50 ft. ☐5	Toilet facilities Flush toilet in str., excl. use ☐1 Flush toilet in str., shared ☐2 Nonflush toilet in structure ☐3 Outside toilet or privy ☐4 No toilet or privy ☐5	Bathtub or shower with running water in structure Exclusive use ☐1 Shared ☐2 None ☐3	Principal lighting equip't Electric ☐1 Gas ☐2 Ker. gasol. ☐3 Other ☐4	Principal refrigeration equip't Mechanical ☐1 Ice ☐2 Other ☐3 None ☐4	Radio in dwelling unit? Yes ☐1 No ☐0	Heating equipment Steam or hot water system ☐1 Piped warm air system ☐2 Pipeless warm air furnace ☐3 Heating stove ☐4 Other or none ☐5	Principal fuel used for heating Coal or coke ☐1 Wood ☐2 Gas ☐3 Electric ☐4 Fuel oil ☐5 Ker. or gasol. ☐6 Other ☐7 None ☐8	Principal fuel used for cooking Coal or coke ☐1 Wood ☐2 Gas ☐3 Electric ☐4 Ker. or gasol. ☐6 Other ☐7 None ☐8 C	Furniture incl. in rent? Yes ☐1 No ☐0 Est. rent without furniture $	Average monthly cost of— Elec. $.... Gas $.... Other fuel $.... Water $....
2	Rooms B	Water Run wat in ☐1 Hd pump in ☐2 Run wat 50ft ☐3 Other 50 ft ☐4 None 50 ft ☐5	Toilet Fl, in, excl. ☐1 Fl, in, shar ☐2 Nonfl, in ☐3 Outside ☐4 None ☐5	Bath Excl. use ☐1 Shared ☐2 None ☐3	Light Elec ☐1 Gas ☐2 Ker. gasol. ☐3 Other ☐4	Refrig Mech ☐1 Ice ☐2 Other ☐3 None ☐4	Radio Yes ☐1 No ☐0	Heating equip't Steam or hot water ☐1 Piped warm air ☐2 Pipeless warm air ☐3 Heating stove ☐4 Other or none ☐5	Heating fuel Coal or coke ☐1 Wood ☐2 Gas ☐3 Elec ☐4 Fuel oil ☐5 Ker or gasol ☐6 Other ☐7 None ☐8	Cooking fuel Coal or coke ☐1 Wood ☐2 Gas ☐3 Elec ☐4 Ker or gasol ☐6 Other ☐7 None ☐8	Furn. in rent? Yes ☐1 No ☐0 Rent without furn. $	Mo. cost Elec. $.... Gas $.... Other fuel $.... Water $
3	Rooms B	Water Run wat in ☐1 Hd pump in ☐2 Run wat 50ft ☐3 Other 50 ft ☐4 None 50 ft ☐5	Toilet Fl, in, excl. ☐1 Fl, in, shar ☐2 Nonfl, in ☐3 Outside ☐4 None ☐5	Bath Excl. use ☐1 Shared ☐2 None ☐3	Light Elec ☐1 Gas ☐2 Ker. gasol. ☐3 Other ☐4	Refrig Mech ☐1 Ice ☐2 Other ☐3 None ☐4	Radio Yes ☐1 No ☐0	Heating equip't Steam or hot water ☐1 Piped warm air ☐2 Pipeless warm air ☐3 Heating stove ☐4 Other or none ☐5	Heating fuel Coal or coke ☐1 Wood ☐2 Gas ☐3 Elec ☐4 Fuel oil ☐5 Ker or gasol ☐6 Other ☐7 None ☐8	Cooking fuel Coal or coke ☐1 Wood ☐2 Gas ☐3 Elec ☐4 Ker or gasol ☐6 Other ☐7 None ☐8	Furn. in rent? Yes ☐1 No ☐0 Rent without furn. $	Mo. cost Elec. $.... Gas $.... Other fuel $.... Water $
4	Rooms B	Water Run wat in ☐1 Hd pump in ☐2 Run wat 50ft ☐3 Other 50 ft ☐4 None 50 ft ☐5	Toilet Fl, in, excl. ☐1 Fl, in, shar. ☐2 Nonfl, in ☐3 Outside ☐4 None ☐5	Bath Excl. use ☐1 Shared ☐2 None ☐3	Light Elec ☐1 Gas ☐2 Ker. gasol. ☐3 Other ☐4	Refrig Mech ☐1 Ice ☐2 Other ☐3 None ☐4	Radio Yes ☐1 No ☐0	Heating equip't Steam or hot water ☐1 Piped warm air ☐2 Pipeless warm air ☐3 Heating stove ☐4 Other or none ☐5	Heating fuel Coal or coke ☐1 Wood ☐2 Gas ☐3 Elec ☐4 Fuel oil ☐5 Ker or gasol ☐6 Other ☐7 None ☐8	Cooking fuel Coal or coke ☐1 Wood ☐2 Gas ☐3 Elec ☐4 Ker or gasol ☐6 Other ☐7 None ☐8	Furn. in rent? Yes ☐1 No ☐0 Rent without furn. $	Mo. cost Elec. $.... Gas $.... Other fuel $.... Water $
5	Rooms B	Water Run wat in ☐1 Hd pump in ☐2 Run wat 50ft ☐3 Other 50 ft ☐4 None 50 ft ☐5	Toilet Fl, in, excl. ☐1 Fl, in, shar. ☐2 Nonfl, in ☐3 Outside ☐4 None ☐5	Bath Excl. use ☐1 Shared ☐2 None ☐3	Light Elec ☐1 Gas ☐2 Ker. gasol. ☐3 Other ☐4	Refrig Mech ☐1 Ice ☐2 Other ☐3 None ☐4	Radio Yes ☐1 No ☐0	Heating equip't Steam or hot water ☐1 Piped warm air ☐2 Pipeless warm air ☐3 Heating stove ☐4 Other or none ☐5	Heating fuel Coal or coke ☐1 Wood ☐2 Gas ☐3 Elec ☐4 Fuel oil ☐5 Ker or gasol ☐6 Other ☐7 None ☐8	Cooking fuel Coal or coke ☐1 Wood ☐2 Gas ☐3 Elec ☐4 Ker or gasol ☐6 Other ☐7 None ☐8	Furn. in rent? Yes ☐1 No ☐0 Rent without furn. $	Mo. cost Elec. $.... Gas $.... Other fuel $.... Water $
6	Rooms B	Water Run wat in ☐1 Hd pump in ☐2 Run wat 50ft ☐3 Other 50 ft ☐4 None 50 ft ☐5	Toilet Fl, in, excl. ☐1 Fl, in, shar. ☐2 Nonfl, in ☐3 Outside ☐4 None ☐5	Bath Excl. use ☐1 Shared ☐2 None ☐3	Light Elec ☐1 Gas ☐2 Ker. gasol. ☐3 Other ☐4	Refrig. Mech ☐1 Ice ☐2 Other ☐3 None ☐4	Radio Yes ☐1 No ☐0	Heating equip't Steam or hot water ☐1 Piped warm air ☐2 Pipeless warm air ☐3 Heating stove ☐4 Other or none ☐5	Heating fuel Coal or coke ☐1 Wood ☐2 Gas ☐3 Elec ☐4 Fuel oil ☐5 Ker or gasol ☐6 Other ☐7 None ☐8	Cooking fuel Coal or coke ☐1 Wood ☐2 Gas ☐3 Elec ☐4 Ker or gasol ☐6 Other ☐7 None ☐8	Furn. in rent? Yes ☐1 No ☐0 Rent without furn. $	Mo. cost Elec. $.... Gas $.... Other fuel $.... Water $
7	Rooms B	Water Run wat in ☐1 Hd pump in ☐2 Run wat 50ft ☐3 Other 50 ft ☐4 None 50 ft ☐5	Toilet Fl, in, excl. ☐1 Fl, in, shar. ☐2 Nonfl, in ☐3 Outside ☐4 None ☐5	Bath Excl. use ☐1 Shared ☐2 None ☐3	Light Elec ☐1 Gas ☐2 Ker. gasol. ☐3 Other ☐4	Refrig Mech ☐1 Ice ☐2 Other ☐3 None ☐4	Radio Yes ☐1 No ☐0	Heating equip't Steam or hot water ☐1 Piped warm air ☐2 Pipeless warm air ☐3 Heating stove ☐4 Other or none ☐5	Heating fuel Coal or coke ☐1 Wood ☐2 Gas ☐3 Elec ☐4 Fuel oil ☐5 Ker or gasol ☐6 Other ☐7 None ☐8	Cooking fuel Coal or coke ☐1 Wood ☐2 Gas ☐3 Elec ☐4 Ker or gasol ☐6 Other ☐7 None ☐8	Furn. in rent? Yes ☐1 No ☐0 Rent without furn. $	Mo. cost Elec. $.... Gas $.... Other fuel $.... Water $
8	Rooms B	Water Run wat in ☐1 Hd pump in ☐2 Run wat 50ft ☐3 Other 50 ft ☐4 None 50 ft ☐5	Toilet Fl, in, excl. ☐1 Fl, in, shar. ☐2 Nonfl, in ☐3 Outside ☐4 None ☐5	Bath Excl. use ☐1 Shared ☐2 None ☐3	Light Elec ☐1 Gas ☐2 Ker. gasol. ☐3 Other ☐4	Refrig. Mech ☐1 Ice ☐2 Other ☐3 None ☐4	Radio Yes ☐1 No ☐0	Heating equip't Steam or hot water ☐1 Piped warm air ☐2 Pipeless warm air ☐3 Heating stove ☐4 Other or none ☐5	Heating fuel Coal or coke ☐1 Wood ☐2 Gas ☐3 Elec ☐4 Fuel oil ☐5 Ker or gasol ☐6 Other ☐7 None ☐8	Cooking fuel Coal or coke ☐1 Wood ☐2 Gas ☐3 Elec ☐4 Ker or gasol ☐6 Other ☐7 None ☐8	Furn. in rent? Yes ☐1 No ☐0 Rent without furn. $	Mo. cost Elec. $.... Gas $.... Other fuel $.... Water $
9	Rooms	Water Run. wat in ☐1 Hd pump in ☐2	Toilet Fl, in, excl. ☐1 Fl, in, shar ☐2	Bath Excl. use ☐1	Light Elec ☐1 Gas ☐2	Refrig. Mech ☐1 Ice ☐2	Radio Yes ☐1	Heating equip't Steam or hot water ☐1 Piped warm air	Heating fuel	Cooking fuel Coal or coke ☐1 Ker or gasol ☐6	Furn in rent? Yes ☐1 ☐0	Mo. cost Elec. $.... Gas $....

SECTION	V. FINANCIAL DATA FOR EACH OWNER OCCUPIED NONFARM UNIT (In structure without business containing not more than 4 dwelling units)		FOR EACH FIRST MORTGAGE OR LAND CONTRACT				
	25	26	27	28	29	30	31
1	Value of property $........ No. of dwlg. units .... D	Mortgage on property Yes ☐1 No ☐0 Present debt On 1st mtg $........ On 2d mtg $........	Regular payments required Monthly ☐1 Quarterly ☐2 Semi-annual ☐3 Annual ☐4 Other reg. pmt. plan ☐5 No reg. pmt. required ☐6 Amount of each pmt. $	Do payments include an amount for reduction of principal? Yes ☐1 No ☐0	[illegible] taxes? Yes ☐1 No ☐0	Interest rate now chg'd E	Holder of first mortgage (or land contract) Bldg. & Loan ☐1 Com. Bank ☐2 Savings Bank ☐3 Life Ins. Co. ☐4 Mtg. Co. ☐5 HOLC ☐6 Individual ☐7 Other ☐8
2	Value of property $........ No. of units D	Mortgaged? Yes ☐1 No ☐0 1st mtg $........ 2d mtg	Payment Mo. ☐1 Qu. ☐2 Semi-an ☐3 An ☐4 Other reg ☐5 No reg ☐6 Amount of each pmt. $	Pmts incl princ.? Yes ☐1 No ☐0	Pmts. incl. taxes? Yes ☐1 No ☐0	Interest rate E	Holder of Mtg. Bldg & Ln. ☐1 Com Bk ☐2 Sav Bk ☐3 Life Ins. ☐4 Mtg. Co. ☐5 HOLC ☐6 Individ. ☐7 Other ☐8
3	Value of property $........ No. of units D	Mortgaged? Yes ☐1 No ☐0 1st mtg $........ 2d mtg	Payment Mo. ☐1 Qu. ☐2 Semi-an ☐3 An ☐4 Other reg ☐5 No reg ☐6 Amount of each pmt. $	Pmts incl princ.? Yes ☐1 No ☐0	Pmts. incl. taxes? Yes ☐1 No ☐0	Interest rate E	Holder of Mtg. Bldg & Ln. ☐1 Com Bk ☐2 Sav Bk ☐3 Life Ins. ☐4 Mtg. Co. ☐5 HOLC ☐6 Individ. ☐7 Other ☐8
4	Value of property $........ No. of units D	Mortgaged? Yes ☐1 No ☐0 1st mtg $........ 2d mtg	Payment Mo. ☐1 Qu. ☐2 Semi-an ☐3 An ☐4 Other reg ☐5 No reg ☐6 Amount of each pmt. $	Pmts incl princ.? Yes ☐1 No ☐0	Pmts. incl. taxes? Yes ☐1 No ☐0	Interest rate E	Holder of Mtg. Bldg & Ln. ☐1 Com Bk ☐2 Sav Bk ☐3 Life Ins. ☐4 Mtg. Co. ☐5 HOLC ☐6 Individ. ☐7 Other ☐8
5	Value of property $........ No. of units D	Mortgaged? Yes ☐1 No ☐0 1st mtg $........ 2d mtg	Payment Mo. ☐1 Qu. ☐2 Semi-an ☐3 An ☐4 Other reg ☐5 No reg ☐6 Amount of each pmt. $	Pmts incl princ.? Yes ☐1 No ☐0	Pmts. incl. taxes? Yes ☐1 No ☐0	Interest rate E	Holder of Mtg. Bldg & Ln. ☐1 Com Bk ☐2 Sav Bk ☐3 Life Ins. ☐4 Mtg. Co. ☐5 HOLC ☐6 Individ. ☐7 Other ☐8
6	Value of property $........ No. of units D	Mortgaged? Yes ☐1 No ☐0 1st mtg $........ 2d mtg	Payment Mo. ☐1 Qu. ☐2 Semi-an ☐3 An ☐4 Other reg ☐5 No reg ☐6 Amount of each pmt. $	Pmts. incl princ.? Yes ☐1 No ☐0	Pmts. incl. taxes? Yes ☐1 No ☐0	Interest rate E	Holder of Mtg. Bldg & Ln. ☐1 Com Bk ☐2 Sav Bk ☐3 Life Ins. ☐4 Mtg. Co. ☐5 HOLC ☐6 Individ. ☐7 Other ☐8
7	Value of property $........ No. of units D	Mortgaged? Yes ☐1 No ☐0 1st mtg $........ 2d mtg	Payment Mo. ☐1 Qu. ☐2 Semi-an ☐3 An ☐4 Other reg ☐5 No reg ☐6 Amount of each pmt. $	Pmts. incl. princ.? Yes ☐1 No ☐0	Pmts. incl. taxes? Yes ☐1 No ☐0	Interest rate E	Holder of Mtg. Bldg & Ln. ☐1 Com Bk ☐2 Sav Bk ☐3 Life Ins. ☐4 Mtg. Co. ☐5 HOLC ☐6 Individ. ☐7 Other ☐8
8	Value of property $........ No. of units D	Mortgaged? Yes ☐1 No ☐0 1st mtg $........ 2d mtg	Payment Mo. ☐1 Qu. ☐2 Semi-an. ☐3 An. ☐4 Other reg ☐5 No reg ☐6 Amount of each pmt. $	Pmts. incl. princ.? Yes ☐1 No ☐0	Pmts. incl. taxes? Yes ☐1 No ☐0	Inter-est rate E	Holder of Mtg. Bldg & Ln. ☐1 Com Bk ☐2 Sav. Bk. ☐3 Life Ins. ☐4 Mtg. Co. ☐5 HOLC ☐6 Individ. ☐7 Other ☐8
9	Value of property	Mortgaged? Yes ☐1 No ☐0	Payment Mo. ☐1 Other reg ☐5 ☐6	Pmts. incl. princ.? Yes	Pmts. incl. taxes? Yes	Inter-est	Holder of Mtg. Bldg ☐1 Mtg. Co. ☐5 ☐6

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sed for Purposes of Taxation, Regulation, or Investigation.

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S. D. No. ______________ E. D. No. ______________

Enumerated by me on ______________________, 1940.

______________________, Enumerator

SHEET NO.
________A

		IV. UTILITY DATA FOR EACH RENTER-OCCUPIED NONFARM UNIT		V. FINANCIAL DATA FOR EACH OWNER-OCCUPIED NONFARM UNIT (In structure without business containing not more than 4 dwelling units)						
						FOR EACH FIRST MORTGAGE OR LAND CONTRACT				
21	22	23	24	25	26	27	28	29	30	31
rincipal fuel d for heating ☐1 Fuel oil ☐5 ☐2 Ker. or gasol. ☐6 ☐3 Other ☐7 ☐4 None ☐8	Principal fuel used for cooking Coal or coke ☐1 Ker. or gasol. ☐6 Wood ☐2 Other ☐7 Gas ☐3 None ☐8 Electric ☐4 C	Furniture incl. in rent? Yes ☐1 No ☐0 Est. rent without furniture $	Average monthly cost of— Elec. $ Gas $ Other fuel $ Water $	Value of property $ No. of dwlg. units D	Mortgage on property Yes ☐1 No ☐0 Present debt On 1st mtg. $ On 2d mtg. $	Regular payments required Monthly ☐1 Other reg. pmt. plan ☐5 Quarterly ☐2 No reg. pmt. required ☐6 Semi-annual ☐3 Amount of each pmt. Annual ☐4 $	Do payments include an amount for reduction of principal? Yes ☐1 No ☐0	Do payments include real estate taxes? Yes ☐1 No ☐0	Interest rate now chg'd % E	Holder of first mortgage (or land contract) Bldg. & Loan ☐1 Mtg. Co. ☐5 Com. Bank ☐2 HOLC ☐6 Savings Bank ☐3 Individual ☐7 Life Insur. Co. ☐4 Other ☐8
eating fuel ☐1 Fuel oil ☐5 ☐2 Ker. or gasol. ☐6 ☐3 Other ☐7 ☐4 None ☐8	Cooking fuel Coal or coke ☐1 Ker. or gasol. ☐6 Wood ☐2 Other ☐7 Gas ☐3 None ☐8 Elec. ☐4 C	Furn. in rent? Yes ☐1 No ☐0 Rent without furn. $	Mo. cost Elec. $ Gas $ Other fuel $ Water $	Value of property $ No. of units D	Mortgaged? Yes ☐1 No ☐0 1st mtg. $ 2d mtg. $	Payment Mo. ☐1 Other reg. ☐5 Qu. ☐2 No reg. ☐6 Semi-an. ☐3 Amount of each pmt. An. ☐4 $	Pmts. incl. princ.? Yes ☐1 No ☐0	Pmts. incl. taxes? Yes ☐1 No ☐0	Interest rate % E	Holder of Mtg. Bldg. & Ln. ☐1 Mtg. Co. ☐5 Com. Bk. ☐2 HOLC ☐6 Sav. Bk. ☐3 Indi-vid. ☐7 Life Ins. ☐4 Other ☐8
eating fuel ☐1 Fuel oil ☐5 ☐2 Ker. or gasol. ☐6 ☐3 Other ☐7 ☐4 None ☐8	Cooking fuel Coal or coke ☐1 Ker. or gasol. ☐6 Wood ☐2 Other ☐7 Gas ☐3 None ☐8 Elec. ☐4 C	Furn. in rent? Yes ☐1 No ☐0 Rent without furn. $	Mo. cost Elec. $ Gas $ Other fuel $ Water $	Value of property $ No. of units D	Mortgaged? Yes ☐1 No ☐0 1st mtg. $ 2d mtg. $	Payment Mo. ☐1 Other reg. ☐5 Qu. ☐2 No reg. ☐6 Semi-an. ☐3 Amount of each pmt. An. ☐4 $	Pmts. incl. princ.? Yes ☐1 No ☐0	Pmts. incl. taxes? Yes ☐1 No ☐0	Interest rate % E	Holder of Mtg. Bldg. & Ln. ☐1 Mtg. Co. ☐5 Com. Bk. ☐2 HOLC ☐6 Sav. Bk. ☐3 Indi-vid. ☐7 Life Ins. ☐4 Other ☐8
eating fuel ☐1 Fuel oil ☐5 ☐2 Ker. or gasol. ☐6 ☐3 Other ☐7 ☐4 None ☐8	Cooking fuel Coal or coke ☐1 Ker. or gasol. ☐6 Wood ☐2 Other ☐7 Gas ☐3 None ☐8 Elec. ☐4 C	Furn. in rent? Yes ☐1 No ☐0 Rent without furn. $	Mo. cost Elec. $ Gas $ Other fuel $ Water $	Value of property $ No. of units D	Mortgaged? Yes ☐1 No ☐0 1st mtg. $ 2d mtg. $	Payment Mo. ☐1 Other reg. ☐5 Qu. ☐2 No reg. ☐6 Semi-an. ☐3 Amount of each pmt. An. ☐4 $	Pmts. incl. princ.? Yes ☐1 No ☐0	Pmts. incl. taxes? Yes ☐1 No ☐0	Interest rate % E	Holder of Mtg. Bldg. & Ln. ☐1 Mtg. Co. ☐5 Com. Bk. ☐2 HOLC ☐6 Sav. Bk. ☐3 Indi-vid. ☐7 Life Ins. ☐4 Other ☐8
eating fuel ☐1 Fuel oil ☐5 ☐2 Ker. or gasol. ☐6 ☐3 Other ☐7 ☐4 None ☐8	Cooking fuel Coal or coke ☐1 Ker. or gasol. ☐6 Wood ☐2 Other ☐7 Gas ☐3 None ☐8 Elec. ☐4 C	Furn. in rent? Yes ☐1 No ☐0 Rent without furn. $	Mo. cost Elec. $ Gas $ Other fuel $ Water $	Value of property $ No. of units D	Mortgaged? Yes ☐1 No ☐0 1st mtg. $ 2d mtg. $	Payment Mo. ☐1 Other reg. ☐5 Qu. ☐2 No reg. ☐6 Semi-an. ☐3 Amount of each pmt. An. ☐4 $	Pmts. incl. princ.? Yes ☐1 No ☐0	Pmts. incl. taxes? Yes ☐1 No ☐0	Interest rate % E	Holder of Mtg. Bldg. & Ln. ☐1 Mtg. Co. ☐5 Com. Bk. ☐2 HOLC ☐6 Sav. Bk. ☐3 Indi-vid. ☐7 Life Ins. ☐4 Other ☐8
eating fuel ☐1 Fuel oil ☐5 ☐2 Ker. or gasol. ☐6 ☐3 Other ☐7 ☐4 None ☐8	Cooking fuel Coal or coke ☐1 Ker. or gasol. ☐6 Wood ☐2 Other ☐7 Gas ☐3 None ☐8 Elec. ☐4 C	Furn. in rent? Yes ☐1 No ☐0 Rent without furn. $	Mo. cost Elec. $ Gas $ Other fuel $ Water $	Value of property $ No. of units D	Mortgaged? Yes ☐1 No ☐0 1st mtg. $ 2d mtg. $	Payment Mo. ☐1 Other reg. ☐5 Qu. ☐2 No reg. ☐6 Semi-an. ☐3 Amount of each pmt. An. ☐4 $	Pmts. incl. princ.? Yes ☐1 No ☐0	Pmts. incl. taxes? Yes ☐1 No ☐0	Interest rate % E	Holder of Mtg. Bldg. & Ln. ☐1 Mtg. Co. ☐5 Com. Bk. ☐2 HOLC ☐6 Sav. Bk. ☐3 Indi-vid. ☐7 Life Ins. ☐4 Other ☐8
eating fuel ☐1 Fuel oil ☐5 ☐2 Ker. or gasol. ☐6 ☐3 Other ☐7 ☐4 None ☐8	Cooking fuel Coal or coke ☐1 Ker. or gasol. ☐6 Wood ☐2 Other ☐7 Gas ☐3 None ☐8 Elec. ☐4 C	Furn. in rent? Yes ☐1 No ☐0 Rent without furn. $	Mo. cost Elec. $ Gas $ Other fuel $ Water $	Value of property $ No. of units D	Mortgaged? Yes ☐1 No ☐0 1st mtg. $ 2d mtg. $	Payment Mo. ☐1 Other reg. ☐5 Qu. ☐2 No reg. ☐6 Semi-an. ☐3 Amount of each pmt. An. ☐4 $	Pmts. incl. princ.? Yes ☐1 No ☐0	Pmts. incl. taxes? Yes ☐1 No ☐0	Interest rate % E	Holder of Mtg. Bldg. & Ln. ☐1 Mtg. Co. ☐5 Com. Bk. ☐2 HOLC ☐6 Sav. Bk. ☐3 Indi-vid. ☐7 Life Ins. ☐4 Other ☐8
ating fuel ☐1 Fuel oil ☐5 ☐2 Ker. or gasol. ☐6 ☐3 Other ☐7 ☐4 None ☐8	Cooking fuel Coal or coke ☐1 Ker. or gasol. ☐6 Wood ☐2 Other ☐7 Gas ☐3 None ☐8 Elec. ☐4 C	Furn. in rent? Yes ☐1 No ☐0 Rent without furn. $	Mo. cost Elec. $ Gas $ Other fuel $ Water $	Value of property $ No. of units D	Mortgaged? Yes ☐1 No ☐0 1st mtg. $ 2d mtg. $	Payment Mo. ☐1 Other reg. ☐5 Qu. ☐2 No reg. ☐6 Semi-an. ☐3 Amount of each pmt. An. ☐4 $	Pmts. incl. princ.? Yes ☐1 No ☐0	Pmts. incl. taxes? Yes ☐1 No ☐0	Interest rate % E	Holder of Mtg. Bldg. & Ln. ☐1 Mtg. Co. ☐5 Com. Bk. ☐2 HOLC ☐6 Sav. Bk. ☐3 Indi-vid. ☐7 Life Ins. ☐4 Other ☐8
ting fuel	Cooking fuel Ker. or gasol. ☐6 ☐2 ☐7	Furn. in rent? Yes ☐1 ☐0	Mo. cost Elec. $ Gas $	Value of property	Mortgaged? Yes ☐1 No ☐0	Payment Mo. ☐1 Other reg. ☐5 ☐6	Pmts. incl. princ.? Yes	Pmts. incl. taxes? Yes	Inter-est	Holder of Mtg. Bldg. ☐1 Mtg. Co. ☐5 ☐6

tions about occupation, industry, and class of worker will relate to the job on which they are currently engaged at the date of the census and not, as formerly, to their usual occupation. Consequently, the results of this census will not be strictly comparable with past census statistics on occupations. It may be possible, however, to determine in a general way which occupations and industries have suffered most from unemployment.

For those seeking work, the last occupation, industry, and class of worker will be reported. Other related items include the number of weeks worked during 1939, the income received in that year from wages or salaries, and the receipt of additional income of 50 or more dollars from other sources.

There has been considerable movement of population within the United States during the past decade. Because so little is definitely known regarding the volume, geographical distribution, and characteristics of this internal migration, a new question on the place of residence on April 1, 1935, will be asked for each person five or more years of age. The results will indicate the population shifts between urban and rural territory as well as between states and broad regions; they will also reveal what kind of people took part in this migratory movement, due largely to the interplay of economic pressure and employment opportunities.

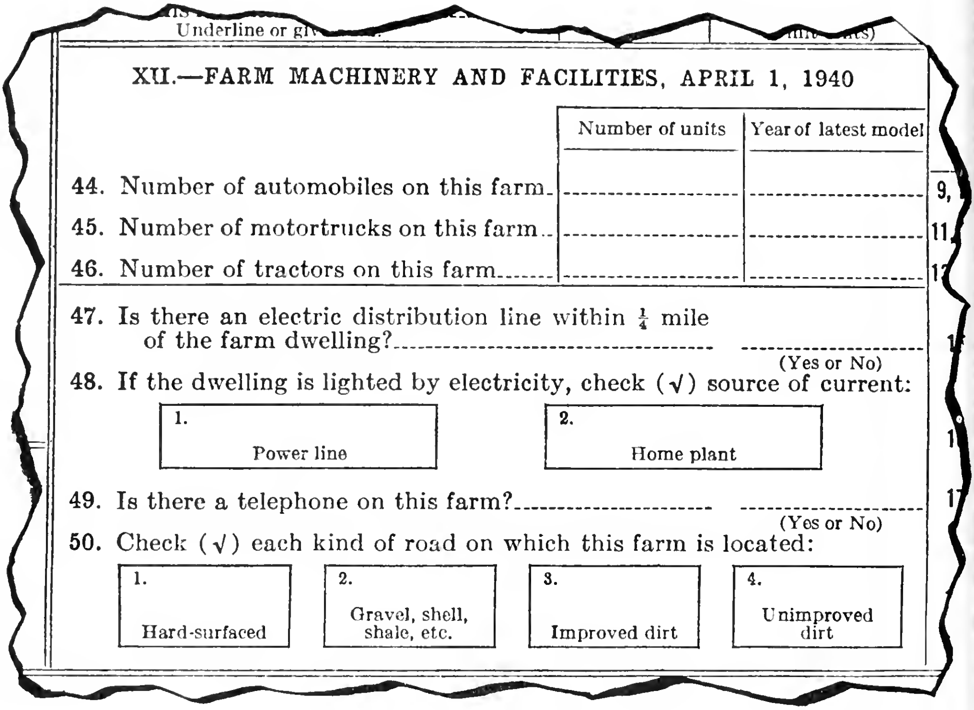
The Housing Census

THE enumerators who ask the population questions will at the same time take the new national census of housing. This marks the first government attempt to obtain a complete, detailed picture of the living conditions of the population. The approach to this objective represents an expansion of the fact-finding surveys conducted in connection with the Real Property Inventories previously mentioned. A sample questionnaire of the occupied-dwelling schedule is reproduced facing this page.

The principal features of the housing census relate to the physical characteristics of the structure in which the home is located, and to the characteristics of the dwelling unit where the family or household resides as distinguished from the main building. The much publicized personal questions on the value of owned property or monthly rental paid, the mortgage status, and the cost of financing are also included.

DETAILED questions seek information about the age of the structure, the need of major repairs, the number of rooms, the extent of overcrowding and doubling up of families, and the essential household facilities such as plumbing, refrigeration, radio, lighting, heating and cooking, and principal fuels used. Information regarding homes with telephones will not be included in this census, though that item will be obtained for farm homes through the medium of the agricultural census. Provision is also made for recording the number of vacant dwelling units and limited information about their characteristics.

This is one part of the decennial census which has been arousing a great deal of controversy. Individuals and organizations have gone on



Underline or g

XII.—FARM MACHINERY AND FACILITIES, APRIL 1, 1940

	Number of units	Year of latest model
44. Number of automobiles on this farm		
45. Number of motortrucks on this farm		
46. Number of tractors on this farm		

47. Is there an electric distribution line within ¼ mile of the farm dwelling? ________ (Yes or No)

48. If the dwelling is lighted by electricity, check (√) source of current:

☐ 1. Power line ☐ 2. Home plant

49. Is there a telephone on this farm? ________ (Yes or No)

50. Check (√) each kind of road on which this farm is located:

☐ 1. Hard-surfaced ☐ 2. Gravel, shell, shale, etc. ☐ 3. Improved dirt ☐ 4. Unimproved dirt

SECTION XII OF THE FARM AND RANCH SCHEDULE

This schedule, slightly enlarged in the reproduction above, is of interest to telephone people because of the inclusion of Question 49—the only appearance of this item on any of the census schedules

record as regarding it an invasion of individual privacy, and it is known that in the past some of the Real Property Inventories met some opposition for similar reasons. It has been pointed out that if the inclusion of the housing schedule arouses resentment, this attitude would be unfavorable to obtaining the best results in other sections of the census.

The Agricultural Census

IN addition to the questions on population and housing, farmers will answer separate agricultural questionnaires. The farm census will seek information regarding acreage, crops and livestock, labor and mechanized equipment, the extent of tenancy compared to farm ownership, and such financial items as farm values, expenditures, debts and taxes. In addition, there are certain questions relating to farm facilities in which the telephone industry is particularly interested, because the extent to which farms are supplied with these modern conveniences serves as one measure of the market for its services. Due to this interest, the section of the farm schedule which contains the questions regarding these features is reproduced in the accompanying illustration.

All crop production and similar data relate to the calendar year of 1939. Data on drainage and irrigation projects connected with farming operations will be included in the agricultural census.

Other Enumerations

The so-called business census will cover the channels and agencies through which commodities are distributed and the essential services rendered. This partly corresponds to the Census of Distribution of 1930 and to the special business census of 1935. Difficulties of classification of business concerns made those censuses of doubtful value in connection with many studies, and too much must not be expected of the present census. However, the only way to find out how to take a satisfactory census of business is by experiment, and there is justification for making the attempt to learn the pertinent facts on this subject.

The scope of this census covers retail and wholesale trade, service businesses and laundries, theatres and other places of amusement, hotels and tourist camps, the construction industry, and sales finance companies. This is the first time there has been a separate schedule for finance companies. Eleven separate schedules will be used for different types of business concerns, breaking down into considerable detail the several branches of the distribution system.

The Biennial Census of Manufactures, covering manufacturing activity in the United States for the calendar year 1939, will be taken in conjunction with the 1940 decennial census. For the purpose of the census, "manufacturing" covers establishments engaged in the processing of goods or in the assembly of parts into a finished product, whose annual production in 1939 was valued at $5,000 or over. The more important features of this census will include the number of plants and value of products, the number of employees and the wages and salaries paid, the cost of materials and the value added by manufacture, and a classification of plants by industry groups. Information also will be recorded on expenditures for recent plant expansion and for new equipment, and for the first time since 1930 a check will be made on power facilities.

The decennial census of mines and quarries will be taken in coöperation with the Bureau of Mines as part of the 1940 Census. This inquiry will include all mining activities for the calendar year 1939. Of special interest in this field, as well as in the larger realm of manufacturing, will be the light it may throw on the increased productivity of labor.

Releasing the Results

The Census Bureau expects to certify the population returns to the President within eight months after the start of the census, for the purpose of reapportioning Congressional representation. It will probably be two years before the population material will be fully available in the final bound volumes, and this will be true of the other censuses. However, upon completion of the census field work, preliminary population figures will be released locally by supervisors for all places having 2,500 or more inhabitants, and in some cases they may give out the results for communities having less than 2,500 population.

It should be emphasized that no family figures or such detailed population data as nativity, age, sex, etc., will be available in any preliminary releases. No definite date for the early release of provisional data from the non-population sections of the census can be predicted, although they are almost certain to be delayed beyond the publication of population figures.

The data in the decennial census of principal interest and usefulness to the telephone industry will be those items which will be most helpful in analyzing and evaluating the market for its services: first, the size of the market measured in terms of families, farms, and firms (the last item classified according to business function); then the distribution of the market by geographical location and by types of political divisions, cities (large and small), suburban places, agricultural areas, and non-farm rural territory. The data on the redistribution of population through migration will be important.

Finally, as to the characteristics of the market, a wealth of material will become available. The relative proportions of native white, foreign born, and colored, the age composition, and the average size of private families are fundamental factors. The amount of education, the employment status, and income levels will establish an economic grading of the market. Furthermore, housing data such as value of property, characteristics of dwelling units, and the equipment and facilities of the homes will greatly assist the statistician and the engineer in their market studies.

Experience has indicated that census data are of much value in the telephone business. It is clear, however, that the extent of their usefulness will depend in a large measure upon careful analysis and intelligent interpretation combined with good judgment, as well as recognition of any limitations inherent in the returns.

MORE TELEPHONE BUILDINGS

IN CONNECTION with a group of photographs of Bell System buildings gathered together some years ago, President Walter S. Gifford of the American Telephone and Telegraph Company wrote:

"These buildings are typical of the structures, large and small, which are being erected to care for the service requirements of the Nation's rapidly growing telephone system. In their design and construction, these buildings reflect the policies of the Bell System. They are planned to provide at reasonable cost for present service needs and for the continuing growth of telephone use. Modern in conception, they also reflect in their substantial character and careful planning something of the System's stability and its regard for the comfort and convenience of its customers and its employees. These buildings contribute toward the achievement of the ideals of the communities in which they are located and exemplify the progressive spirit which has made possible modern telephone communication as it is today and as it will be in the years to come."

The group illustrated on the following pages, representative of the varied sizes and types of the many buildings constructed in recent years, is indicative of the Bell System's adherence to those objectives.

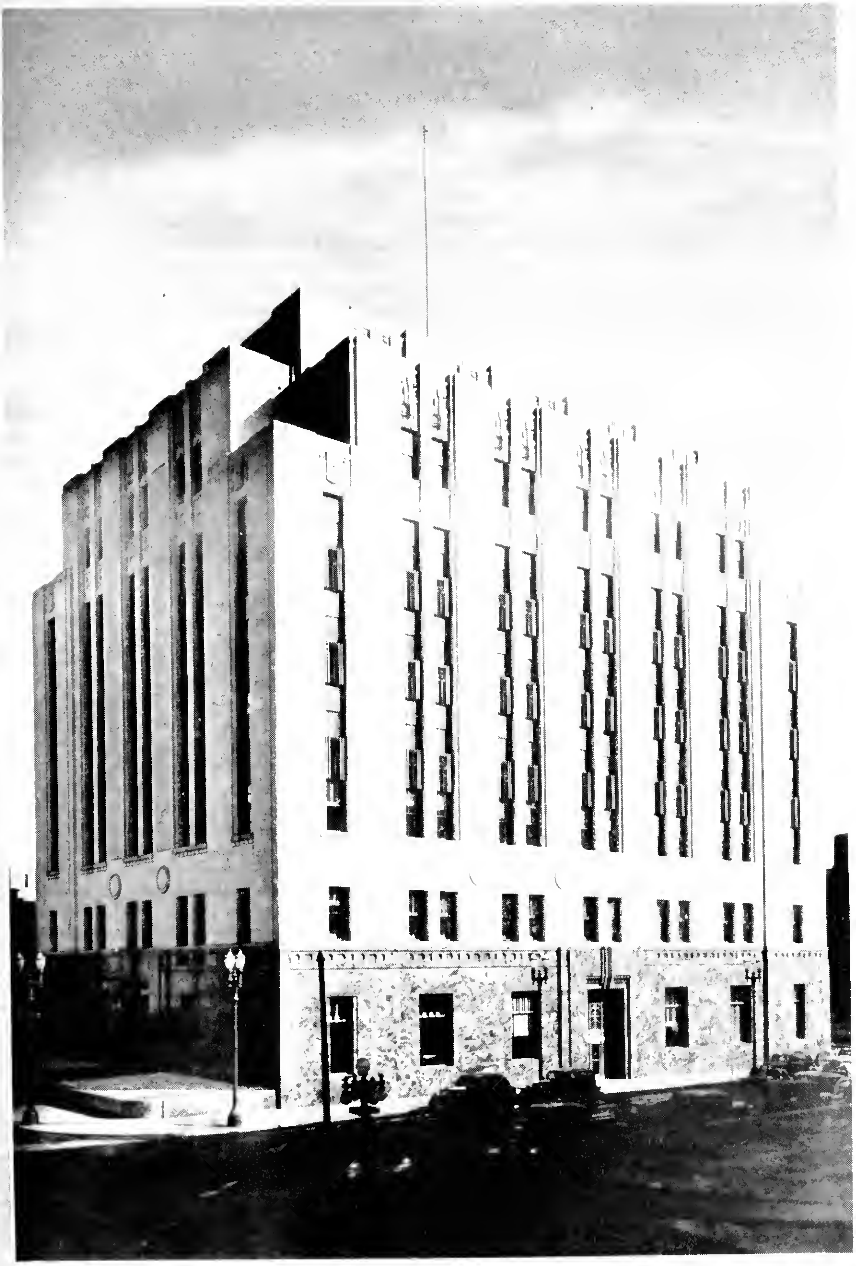
A similar group of System buildings was shown, under the same title, in the BELL TELEPHONE QUARTERLY for October, 1936.

NEW HAVEN, CONN., ADMINISTRATION

R. W. FOOTE AND DOUGLAS ORR, *Architects*

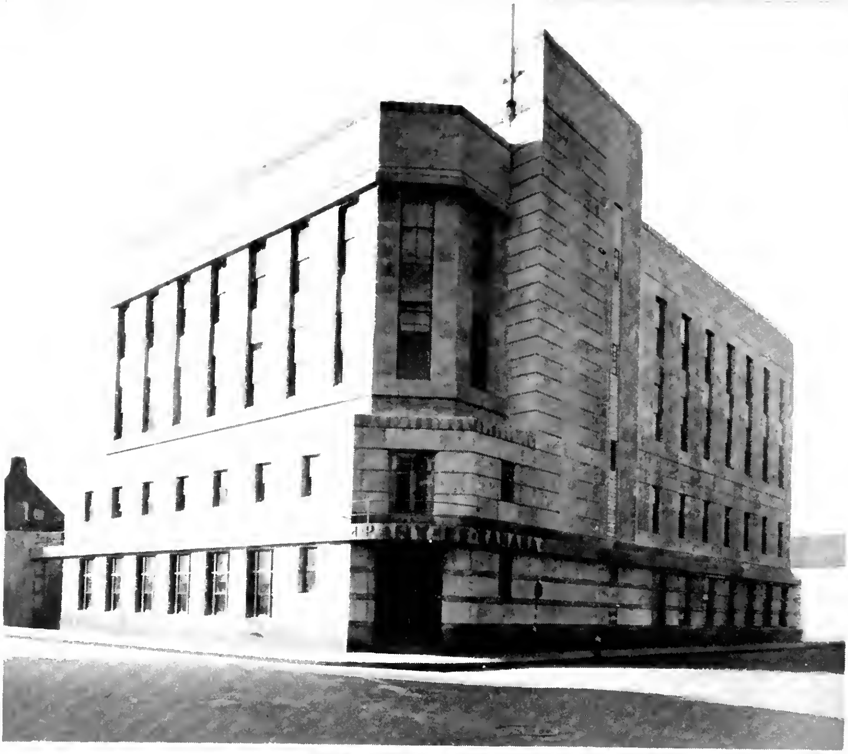
BROOKLYN, N. Y., ADMINISTRATION

Voorhees, Gmelin & Walker, *Architects*



ST. PAUL, MINN., DOWNTOWN

C. H. Johnston, *Architect*



OTTAWA, ONT., CANADA

E. I. Barott and F. J. Macnab, *Architects*

CLEVELAND, OHIO, LAKEWOOD

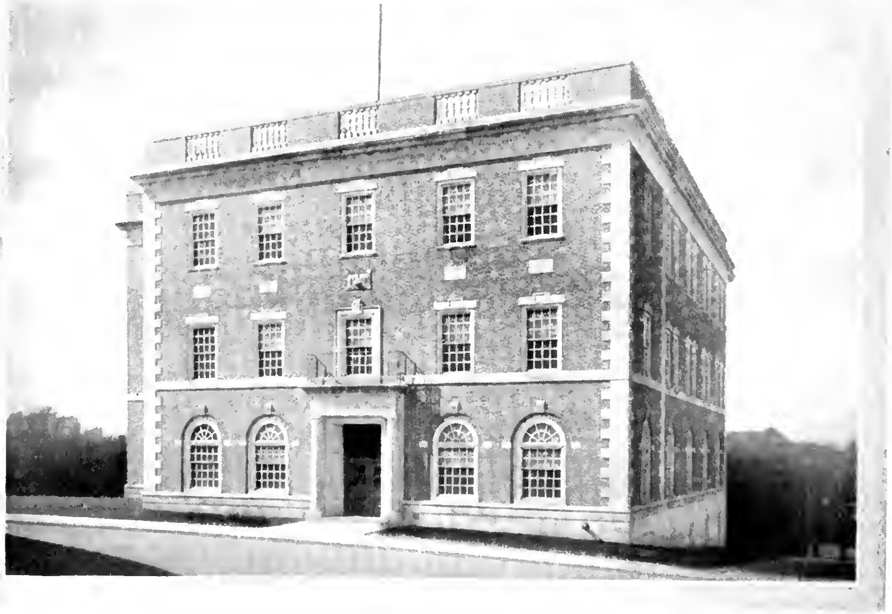
Edward G. Conrad, *Architect*

SPRINGFIELD, ILL.

Holabird & Root, *Architects*

DENVER, COL., NORTH

R. C. Bryant, *Architect*

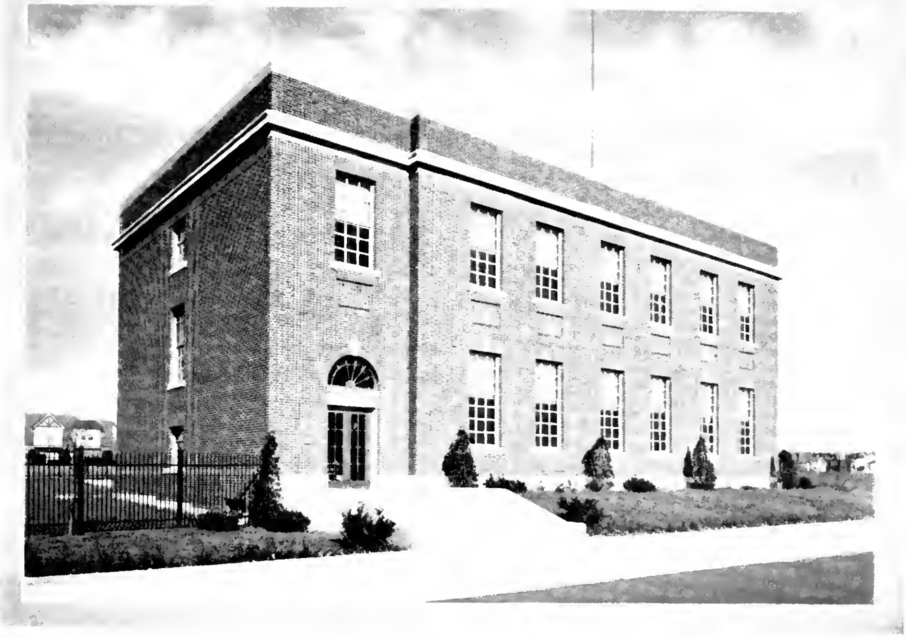


CHARLESTON, S. C.

Hentz, Adler & Shutze; J. Warren Armistead, Associate; *Architects*

EAU CLAIRE, WIS.

Herbst & Kuenzli, *Architects*

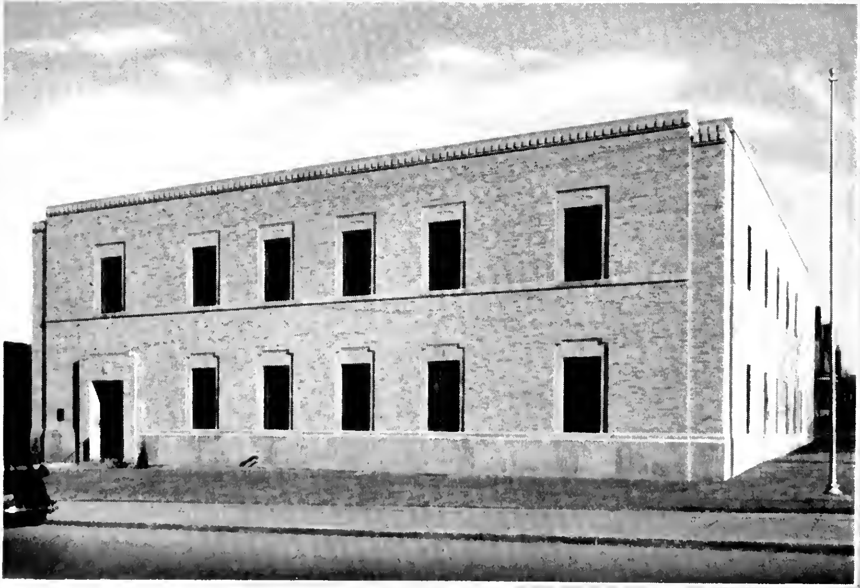


CORPUS CHRISTI, TEX.

I. R. TIMLIN, *Architect*

PHILADELPHIA, PA., MAYFAIR

ZANTZINGER & BORIE, *Architects*



GLENDALE, CAL.

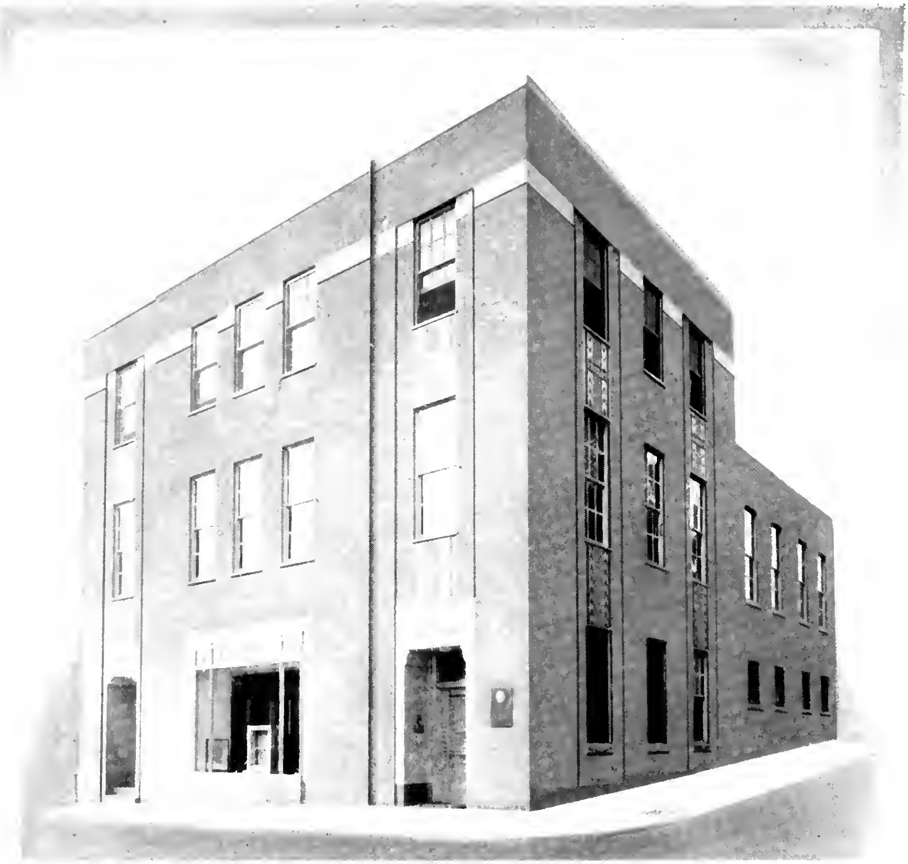
John Parkinson & Donald B. Parkinson, *Architects*

KANSAS CITY, KAN., DREXEL FAIRFAX

I. R. Timlin, *Architect*

CHICAGO, ILL., OAKLAND
Holabird & Root, *Architects*

SANTA FE, N. M.
R. C. Bryant, *Architect*

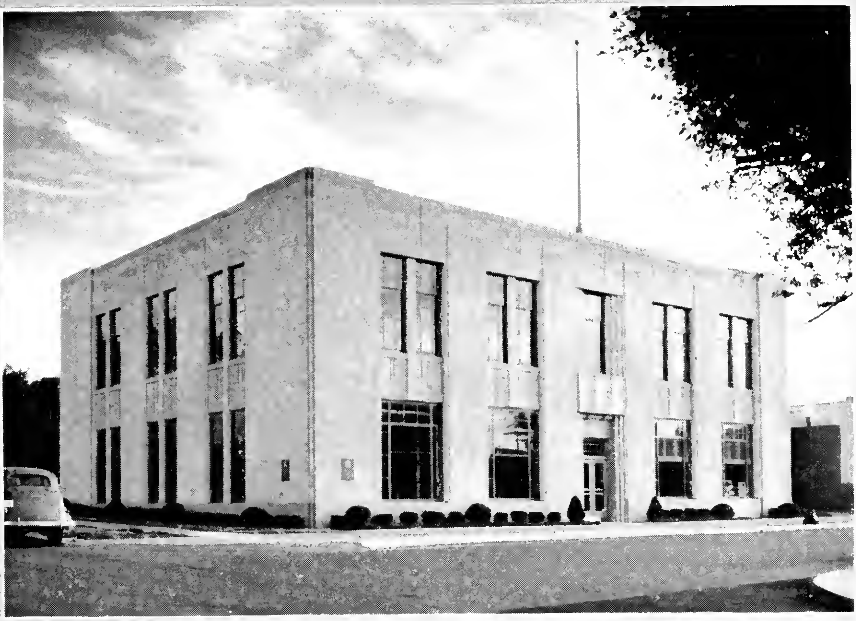


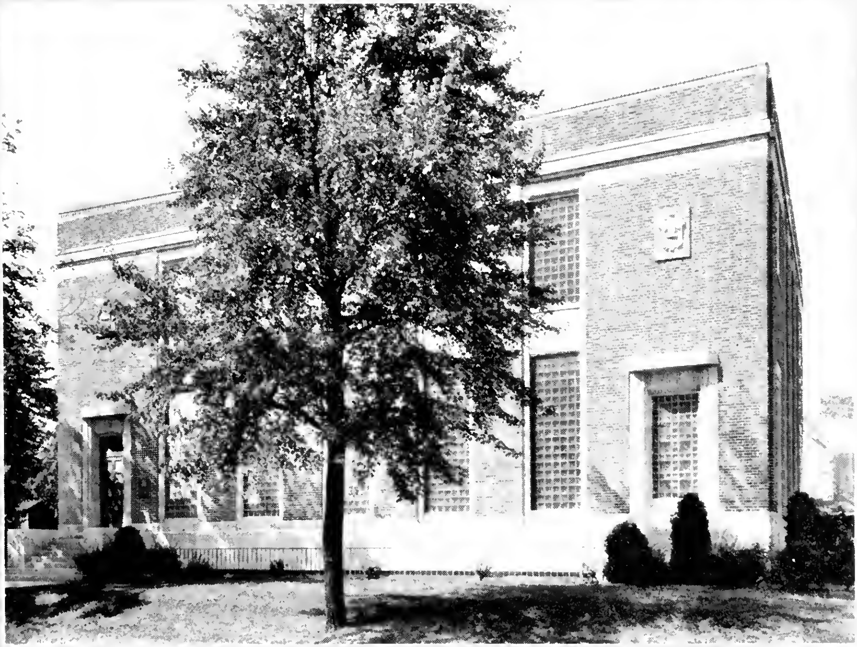
MORGANTOWN, W. VA

Meanor & Handloser, *Architects*

DETROIT, MICH., VERMONT

Smith, Hinchman & Grylls, *Architects*





OLYMPIA, WASH.

BEBB & GOULD, *Architects*

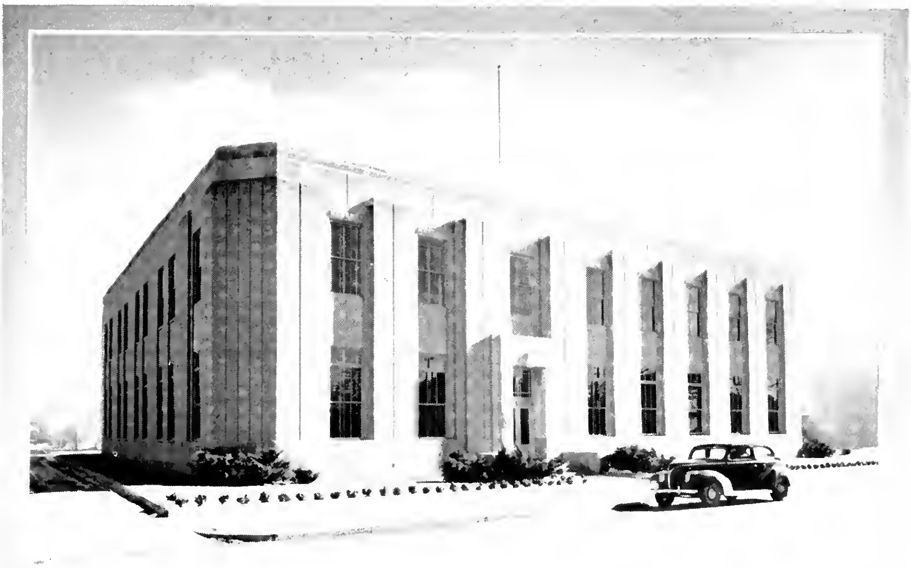
CINCINNATI, OHIO, VALLEY

HARRY HAKE & HARRY HAKE, JR., *Architects*

MILLBURN, N. J.

NORWOOD, MASS.

P. A. Hopkins and Densmore, LeClear & Robbins, *Architects*

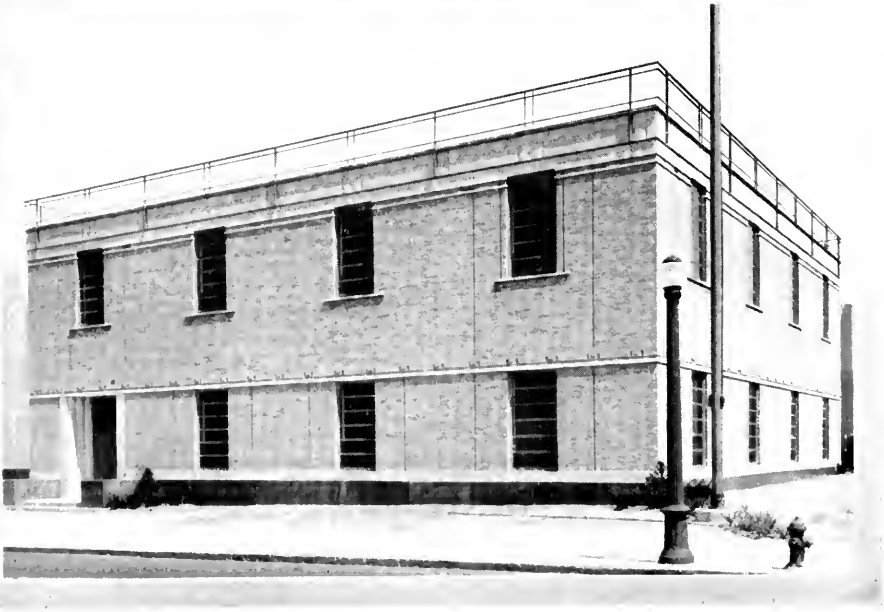


ARLINGTON COUNTY, VA., CHESTNUT

Merrill C. Lee, *Architect*

MARSHALLTOWN, IA.

John Normile, *Architect*



ANNAPOLIS, MD.
TAYLOR & FISHER, *Architects*

BUFFALO, N. Y., HUMBOLDT-TYLER
VOORHEES, GMELIN & WALKER, *Architects*

HOLLY OAK, DEL.

MIAMI BEACH, FLA., NORTH

Hentz, Adler & Shutze; J. Warren Armistead, Associate; *Architects*

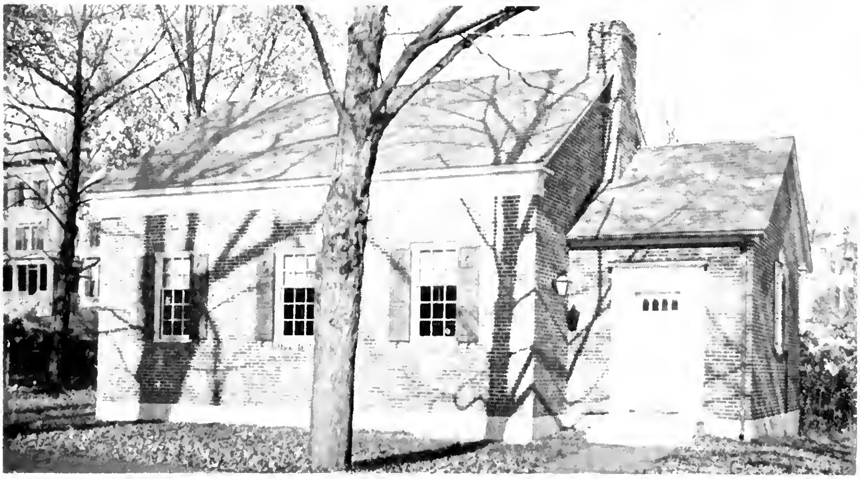
NETCONG, N. J.

SOUTHOLD, N. Y.

EAST BERNE, N. Y.
F. A. Ward, *Architect*

PERRYSVILLE, PA.
Press C. Dowler, *Architect*

FAIRFIELD, CONN.
Douglas Orr, *Architect*



FRANKFORT, KY., LONG LINES REPEATER STATION

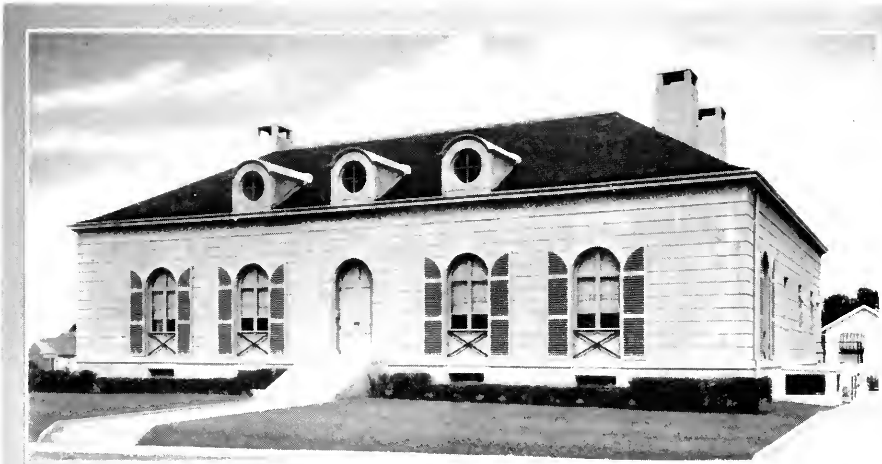
Harry Hake & Harry Hake, Jr., *Architects*

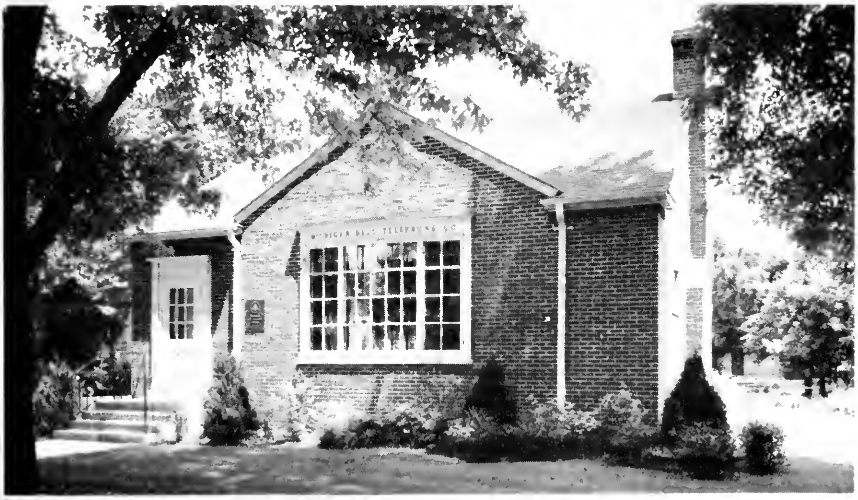
INDIANAPOLIS, IND., BROADWAY

Vonnegut & Bohn, *Architects*

WESTBORO, MASS.

Densmore, LeClear & Robbins, *Architects*





SHREVEPORT, LA., NO. 7

Hentz, Adler & Shutze; J. Warren Armistead, Associate; *Architects*

MANAHAWKIN, N. J., LONG LINES RADIO-TELEPHONE RECEIVING STATION

Voorhees, Gmelin & Walker, *Architects*

ROCHESTER, MICH.

Smith, Hinchman & Grylls, *Architects*

STE. ANNE DE BELLEVILLE, P. Q., CANADA

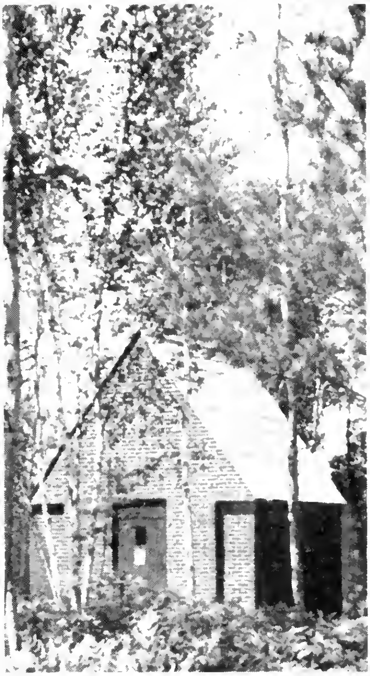
F. J. MacNab, *Architect*

TOLEDO, OHIO, WALBRIDGE

Mills, Rhines, Bellman & Nordhoff, *Architects*

CINCINNATI, OHIO, DELHI

Harry Hake & Harry Hake, Jr., *Architects*



NORFOLK, VA., HARBOR AND COASTAL RADIO-TELEPHONE STATION

Merrill C. Lee, *Architect*

TROUT LAKE, WIS.

TOLEDO, OHIO, LONG LINES TYPE K CARRIER EQUIPMENT STATION

THE TELEPHONE AS A SOCIAL FORCE*

As an Instrument of National Solidarity, and as a Means for Expediting Business and Personal Affairs, the Service Makes Significant Contributions to the Country's Progress

By ROBERTSON T. BARRETT

During the pioneering days, when new areas were being opened in the West, various forms of *one-way* communication served the needs of the nation fairly well. It took days or weeks to send a letter and receive a reply; it often took hours, and always minutes, to send a telegram and get an answer back. Up to the end of the first century of our national history, or thereabouts, nobody particularly cared. But with the faster tempo of industry and commerce, the time was soon to come when a nation geared to high speed would no longer be satisfied to make its business and social contacts by means of *one-way* communication, no matter how rapid it was. The needs of the nation demanded some form of communication that could overcome distance and time, but that would be, nevertheless, as intimate and personal, as direct and reciprocal, as a face-to-face conversation. That form of communication only the telephone, by transmitting the voice itself, could provide.

Not that the nation as a whole was as yet, in 1876, at all aware that the telephone could or would meet this need. It was desperately hard, at first, for Bell and his financial backers to persuade the "practical" business men of their day that the telephone was anything more than an amusing toy. As an instrumentality of human service, as a force that could have any possible historical or social significance, they saw no future for it. But that future was assured, for the need for the telephone existed, though perhaps only potentially. And as the need grew with changing conditions, and as it was met by the creation of a telephone service that was best suited to those conditions, the mark which the telephone was making upon American life became more and more indelibly impressed upon the nation as a whole—which is the measure of the telephone's historical significance.

It is almost a platitude to say that in a democracy, as in no other form of government, an enlightened public opinion is one of the chief foundation

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* Parts of an address delivered on April 1, under the title "The Historical and Social Significance of the Telephone," in the series of Out-of-Hour Lectures, 1939–40, given by the New York Telephone Company at its Headquarters in New York City.

stones of wisdom and fairness in the making of laws and of intelligence and integrity in their administration.

Now, hardly less important than facilities for the publication and distribution of the printed word, as instrumentalities for the formulation of public opinion, are those which have to do with the transmission of intelligence over distances. Common understanding and enlightened public opinion are almost exactly proportional to the number and efficiency of facilities for a free exchange of ideas between individual and individual, state and state, section and section.

A Free Press and Enlightened Public Opinion

Due to many noteworthy advances in journalism since 1876, the press has come to play an increasingly important role as a moulder of public opinion during that period. Not the least of these advances is the use of the telephone in newspaper work. We need have learned very little about how a modern newspaper is put together to know that in the process of getting the news, and getting the opinions of leading men on vital issues, the telephone is a factor of outstanding importance.

Without telephone service, modern journalism would be impossible. Trace any piece of news on the front page of your daily paper, tomorrow morning, to its source, and I venture to assert that, somewhere along the line between the event which is recorded and publication of the story in the paper, you will find a reporter at a telephone, talking his story to a "re-write man" at the office of a newspaper or a press association. And the chances are that you will find this combination of speaker and listener repeated many times in connection with a single news story, as facts are checked back, new angles explored, new developments discovered. Thus, in large measure by telephone, is America's news collected.

And by facilities which telephone research has made possible, this news is distributed to hundreds or thousands of newspapers from one end of the country to the other. By teletype, by the transmission of photographs or facsimiles over wires provided by the Bell System and, to some smaller papers, by the telephone itself, this news is sped throughout the nation—and as it appears in print, it becomes the stuff out of which public opinion is created.

Within the past decade and a half or so, two other potent instrumentalities for the formation of public opinion have appeared on the American scene—both of them direct results of telephone research. The sound moving picture, as we now know it, was developed and first demonstrated by Bell System engineers. Even more directly, the radio telephone is, of course, a descendant of Bell's telephone of 1876. In radio network broadcasting, moreover, the highly engineered circuits used in linking hundreds of stations with the source of the broadcast material are made possible by telephone research and are provided over the nation-wide web of wires which the Bell System has thrown across the continent.

Profound, indeed, have been the changes in this one aspect of American life since Bell spoke the first sentence over the telephone, on that March day in 1876. One of the most significant of the telephone's contributions to the life of our nation, as a nation, has been that it has helped to bring about what may truly be called a sense of national solidarity. We do not, and never shall, all think exactly alike; but modern communication has made it possible for us to learn what our neighbors—even those across the continent—are thinking in regard to the same problems that confront us.

These communication facilities—and among these the telephone is by no means the least effective or the least important—have given a new meaning to the principle of majority rule; have afforded, for majorities and minorities alike, an opportunity of expressing their opinions to audiences which have grown larger and larger in numbers and wider and wider in geographical distribution; have afforded new guarantees that, whatever may be the conflict between majorities and minorities, the United States, in its essential principles and purposes, shall still remain *united.*

Let us consider another phase of the influence of communications in general and of the telephone in particular as factors in the functioning of our democratic form of government. It is said that Daniel Webster expressed himself as strongly opposed to the annexation of Oregon to the United States because, as he contended, a Congressman elected to represent that region in Washington would have to spend most of his two-year term in traveling to the national capital and back again, and while there he would have no means of knowing the wishes of his constituents on issues before Congress.

That was a very real difficulty in Webster's day. But all modern forms of communication have played important parts in keeping our lawmakers in touch with their distant constituents—as witness the floods of letters and telegrams which pour into Washington when the public becomes really excited. Public opinion has found new ways of expressing itself. But of all these forms of communication, the telephone is the most direct and personal, and I dare say that many nebulous ideas on the part of legislators, and perhaps of executives, have been transformed into history-making decisions in the course of long distance telephone calls between Washington, D. C. and points north, east, south and west.

Antidote for Provincialism

Another aspect of the telephone's significance as a maker of American history is its influence as an antidote to provincialism. When Patrick Henry cried, "I am not a Virginian, I am an American," he voiced a sentiment to which we all, I am sure, subscribe—in principle. But in practice, it is perhaps more characteristic of Americans than of any other people in the world to cherish an inordinate pride in the particular spot on the map that they call home. In his delightful poem, "The Village Oracle," Joseph C. Lincoln graphically portrays and personalizes this particular form of provincialism:—

Old Dan'l Hanks, he says this town
Is just the best on earth;
He says there ain't none, up nor down,
That's got one half her worth;
He says there ain't no other state
As good as our'n, nor near
And all the folks that's good and great
Are settled right round here.

Says I, "D'y'ever travel, *Dan?"*
"You bet I ain't," says he;
"I tell you what, the place I got
Is good enough for me!"

We are all, I am afraid, Dan'l Hankses at heart, and we would be even more provincial in our viewpoints if it were not for modern communication methods. As long ago as 1834, a Postmaster General of the United States, in commenting on the fact that some mails had been carried on railroad trains, said: "That which shortens the time of communication, and facilitates the intercourse between distant places, is like bringing them nearer together. While it affords convenience to men of business, it tends to *counteract local prejudices, by enlarging the sphere of acquaintance.*"

That was written more than a hundred years ago, forty years or more before the telephone was invented. It is as true now as it was then, and far more so. For the telephone does more than merely "shorten the time of communication"—it actually projects human personalities. You cannot talk to a man in Boston, or Chicago, or New Orleans, or San Francisco—even though every word you both speak has to do with matters that are "strictly business"—without finding out something about what kind of man he is, or revealing what kind of man you are. It is an education in Americanism thus to become acquainted with our fellow Americans. The facilities which make possible those long distance meetings of mind with mind are national assets of incalculable value.

One other point, while we are on the national aspects of the subject we are discussing: the significance of the telephone as related to national emergencies. Disasters like the hurricane of 1938 are so far-reaching in their effects that, although their physical destruction may be confined to one state or a half a dozen states, we have come to recognize them, quite properly, as national emergencies. When such disasters strike, communication becomes of more than ordinary importance, and the swift, two-way service that the telephone affords becomes of even greater importance than other forms of communication.

THERE is no need to tell telephone people of how telephone people behave in such an emergency, nor to attempt to evaluate the significance of an efficient, dependable telephone service to the nation, as a nation, when such disasters occur.

And there is, unfortunately, another form of national emergency—the emergency of American participation in war. Those of us who remember the World War years need not be reminded, I am sure, of the significance of a nation-wide telephone service—of the part which the telephone, and telephone men and women, played in the making of the American history that was written during those tragic years. And I do not need to tell you, as telephone people, that if, as we hope may never be the case, America is called again to face such an emergency, America must face it as a *united* nation, and that, once more, the telephone must play its part in keeping it *united* in thought and word and action, as well as in name. And, if such an emergency arises, you and I, or the telephone men and women of that day who are our successors, will be making American history, just as telephone men and women have always done in all emergencies.

Service of National Significance

THE historical significance of the telephone—that is, its effect upon the nation as a whole—is chiefly a matter of the significance of the fact that the United States *has* a *nation-wide* telephone service.

Now, it is important to remember that nation-wide telephone service is celebrating its twenty-fifth anniversary this year. Just a quarter of a century ago, on January 25, 1915, the first transcontinental telephone line was opened for service. Before that, there had been no service that included the whole of the United States. It is, therefore, perhaps peculiarly appropriate that we should have devoted a portion of our discussion to the national or historical aspects of the significance of the telephone, of telephone service, and of the work which we, as telephone people, are doing.

We have found that the historical or national significance of the telephone grows chiefly, though not exclusively, out of the improvement and extension of facilities for *long distance* service. Similarly, we shall find, I think, that its social significance is chiefly, though not exclusively, a matter of the growth and improvement of *local* service. What the telephone has done to change the lives of men as they live in their own homes, as they work in their own offices and, to a more limited degree, as they spend their leisure hours during week-ends, holidays and vacations—that is the basis of its social significance.

Beginning nearest home—with urban and suburban conditions—we know that the lives you and I have lived since we awoke this morning, and shall live until we go to bed tonight, are far different from those we would have lived if Bell or someone else had never invented the telephone. Certainly our business life is geared to the tempo which the telephone sets. We make a dozen business contacts today in the time which the business men of the 'eighties spent in making one. We not only project our personalities to distant places—we multiply our personalities. We defy nature by being in two places at once. If we use a conference circuit, the number of places we can be at the same time may be greatly extended.

BUT in its social aspects, the business telephone is, of course, less directly important than the residence telephone. We spend, on the average, only about a third of each twenty-four hours in earning our living; the remainder we spend in rest, recreation, or in those human contacts which have to do with our life as social beings. During these hours, the telephone influences us not as we make a living, but as we live.

The Servant of the Home

IF we go back once more to the state of telephone development as it existed fifty years ago, we shall find that a very large proportion of all the telephones in service were business telephones. The invention of Bell had won recognition as a valuable adjunct to the doing of the world's work in office and factory. It had not yet gone far toward winning like recognition as a social instrumentality. America had not yet become a nation of home telephones. Such homes as had telephones were the homes of the wealthy or the comparatively well-to-do.

Now, during the past fifty years, the home telephone has come to be considered no longer a luxury, but a necessity. In the earlier stages of telephone development, people installed telephones, and particularly in their homes, only when they were reasonably assured that such telephones would be frequently used. Now they install them, even though they may be used relatively infrequently, because they are recognized as necessities. They are installed not alone on the basis of their actual use, but on the basis of their potential usefulness; not on the basis of the number of calls that will actually be made over them, but on the basis of the value of a single call, made at a time when swift and dependable communication is absolutely essential.

This increase in the number of homes which have telephones has profoundly affected our social life. We said a moment or two ago that every act, from the time we arise until we go to bed, is likely to be influenced in some way by the availability of telephone service. As a matter of fact, even our hours of sleep are affected—for telephone service is a twenty-four hour service and the telephone at our bedside stands guard over us during the night hours, to summon aid if an emergency arises. The communication which the telephone stands ready to provide has been and is a vital factor in the protection of life and property against the enemies of law and order. It is a stabilizing factor in society; a preserver of the peace; an instrumentality of safety, security, and orderly living.

IF the telephone guards us while we sleep, it touches our lives during our waking hours in scores of ways of which we are, in many cases, scarcely aware. We arise and, in due course, find ourselves at the breakfast table. The fruit with which we begin our repast was, in all probability, guarded from frost while it was growing through weather warnings made possible because Bell did what he did in 1876 and because of what a lot of Bell System people have been doing ever since. In all probability it was sold to some wholesale fruit dealer as a result of a long distance telephone call. Ten chances to one it was ordered, by the Little Lady who sits across the breakfast table from us, in the course of a telephone call to the retail store around the corner—along with the breakfast bacon, the coffee, the bread for the toast, the butter.

The truth of the matter is that the telephone has profoundly affected the distribution of the food, clothing, and other necessities for which a part of our budget goes. It has helped to facilitate and extend production and distribution so that, in many cases, retail costs have been reduced through increased volume of sales. As a result, you and I can now afford to eat and wear what our fathers thought to be luxuries, beyond their reach. It has not been the only factor, but it *has* been a factor, in bringing about the standard of living of which we Americans are so justly proud. We are what we are, economically, and hence socially, in no small part because rapid and direct communication by the spoken word has helped to gear the production and distribution of necessities and luxuries alike to an increasing tempo.

IT is to be admitted that a high standard of living has not solved and cannot alone solve all of our social problems. The fact that great numbers of people have roofs over their heads and food in their stomachs does not, unfortunately, prevent us from having great numbers of people who have neither of these things to any satisfactory degree. So that any contribution which the telephone has made toward bringing about in America better economic conditions has been, at best, of only indirect social significance.

But the telephone has had a much more direct bearing on the relationships between men and their fellows. There is inherent in the philosophy of most individuals, and in the point of view of most families, a sort of family provincialism that is only an abridged edition of the provincialism to which we have already referred as applying to communities. It is expressed in the words of the Deacon who, saying grace, offered this petition:

O Lord, bless me and my wife;
My son John and his wife—
Us four
And no more.

The telephone, I submit, has social significance because it is peculiarly fitted to act as an antidote for that kind of smugness, narrowness, and self-satisfaction. Provided at a cost so low that it is within reach of millions, telephone service cuts across the lines of economic classification and social caste. It is not the peculiar property of the rich, the cultured, or the politically powerful. It serves all who need it, regardless of birth or background, race, creed, or religion. And because it is thus all-inclusive, it makes its users better citizens of the American democracy.

Transacting the Business of the Community

HAVE we ever stopped to think—we telephone folks who live in suburban communities—how much of our community business is transacted by telephone? And by community business I do not mean business in the ordinary sense—the buying and selling of bread, butter, and other necessities. By "community business" I mean the more important business of getting along together, coming to know each other better, sharing our community responsibilities with each other. Have we ever stopped to think how much of that kind of vitally important business is handled, quickly and efficiently —and withal sympathetically and understandingly—because you and I and most of the other folks like us have telephones in our homes?

Those of you who live in suburban communities will testify, I am sure, to the important part which the telephone plays in the activities of such institutions as the local churches, the hospital, the Red Cross, the community improvement association (or its equivalent under another name), the parent-teachers' organization, and other projects, enterprises, movements, or groups of people that are essentially public-spirited and community-minded in purpose and in practice. A large proportion of the work of such organizations is done, not at formal meetings, but by means of conversations over the telephone. These contacts not only facilitate the particular work with which the discussions are concerned, but draw neighbor nearer to neighbor and help to create a community consciousness.

Use of Local Communications is Increasing

There seems to be evidence that these *local* contacts, not alone by telephone, but by mail and other means of communication, are increasing more rapidly, in proportion, than contacts which reach beyond the limits of the communities in which men make their homes. During the administration of President Hoover, a committee was appointed to study Social Trends as they were then manifesting themselves. One of the aspects of the subject to which investigators were assigned was Communication, and a section of the committee's report on this subject, by Malcolm M. Willey and Stuart A. Rice, affords much to reward a reading, in spite of the fact that it was predicated on conditions existing a decade or more ago.

Among other interesting points brought out was a study of the frequency with which the average American utilized the various communication agencies at his disposal. A tabulation was included which showed the frequency rates, or "average utilizations," of each agency, as calculated for the years 1907 and 1927.

It was shown that in 1907, the average person in this country received a local letter once in every 18 days; in 1927, once in every 9 days. He received a non-local letter once in six days in 1907; once in four days in 1927. He took part in a local telephone call once in three days in 1907, and once in one and one-half days in 1927. He took part in a toll telephone call once in four months and fifteen days in 1907, and once in one month and ten days in 1927. He received a telegram once in eleven months and two days in 1907 and once in six months and twenty-three days in 1927. The receipt of a cablegram, according to these statistics, seems to have been something like the appearance of Halley's comet. You and I average Americans got one once in fourteen years, three months and fourteen days, as of 1907, and once in eight years, four months and two days in 1927.

Among the observations based upon this study were:

> "Local contacts are more numerous than non-local contacts, because of the wide diffusion and

habitual use of the telephone, which instrument dominates the field."

"Relatively, local contacts have increased more rapidly than non-local contacts."

THE report states: "In general, the tabulation indicates that except for toll telephone calls, contacts within narrower boundaries that may be designated as the local area have been increasing at a more rapid rate than contacts that are non-local. And the single exception may in reality not be such, since it involves a tremendous traffic in suburban telephone messages which may be of local significance."

The writers went on to suggest what was admittedly only an hypothesis: "The intensification of local contacts may act to preserve and even enhance local patterns of habit, attitude and behavior, and serve as an inhibitor of the process of cultural leveling which is so commonly assumed as an outstanding and unopposed tendency of contemporary life."

It has been impossible to obtain comparable figures, so as to bring this tabulation up to date. It seems quite likely that the trend then commented on, toward a more rapid increase of local contacts than of those which are non-local, has continued. But even if it has, the hypothesis above quoted will still remain—an hypothesis.

The Telephone: A Force both Centripetal and Centrifugal

THIS much seems certain, however, and it is not based on hypothesis alone: The telephone *does* exert a force as a factor in our social life, and that force is sometimes centripetal, sometimes centrifugal. Local telephone conversations with our community neighbors do make us think, if not all alike, at any rate like members of the same community, having common interests. They tend to draw us toward the center of things in the locality in which we live. We are, I think it is safe to say, a little better residents of Montclair, or Pelham or Roslyn or what-you-will because Bell managed to say, "Come here, I want you!" over a wire to Watson some sixty-four years ago.

Toll telephone calls, on the other hand, tend to exert a force that is centrifugal, and, generally speaking, this force is in direct proportion to the length of haul involved in the call. The longer the circuit over which the conversation takes place, the more these telephone talks are likely to take both speakers outside of the rather narrow circle of their own community interests.

A study of the increased average length of haul of Long Lines telephone messages would, if time permitted, prove enlightening and heartening. More and more the telephone is enabling us to extend, in miles, the reach of our contacts with our fellows. Year by year, the length of haul of long distance telephone messages is increasing. The average air-line length of haul on long distance telephone calls has gradually increased from about 201 miles in 1928 to about 248 miles in 1938, and, I understand, this trend toward longer and longer hauls is still manifesting itself.

Translated from the terms of statistics to those of social—and, if you will, historical—significance, this means that Americans are not only talking more and more with each other by telephone, but are talking farther and farther. They are extending the circumference of the circle of telephone contacts with each other. They are coming to know each other a little better. And because of these increasing and extending contacts, they are the better citizens of the country in which they live; more useful members of society.

IT would be the worst form of smugness to pretend that we, here in America, have achieved anything like the degree of social or national solidarity that is to be desired. It would be hardly less smug of us, as telephone men and women, to bemuse ourselves into thinking for a moment that the telephone has been the only factor that has helped to bring about such solidarity as we have attained. But we shall be doing ourselves a disservice, and failing to show a proper respect for our high calling, if we do not remind ourselves, now and then, that what we are doing in our daily jobs really *does* matter; that the telephone really does have some social importance; that we are making our bit of American history every time we do the smallest part of whatever our job is; that, in whatever we do, we are helping the telephone to make its mark and set its seal upon the record of the changes in men's relationships that make up human progress.

We shall do well if we make it a point never to forget that we are engaged in providing a service that is, and that we must help to keep, socially and historically significant.

STANDARDIZING BUSINESS PAPERS

Efficiency and Economies in the Purchasing of both Paper and Printing for the Bell System Followed the Organizing of These Important Items of Supply

By JAMES J. MURPHY

The birth and development of the telephone directory, and the part played by standardization and centralized purchasing in evolving the books which today serve the users of Bell System telephones, were described in a recent issue of the QUARTERLY.* Standardization and centralized supply arrangements have been applied not only to directories but also to other items of supply which, while less familiar, are nevertheless important in the conduct of the business. Business papers are notable examples.

These are the papers used for records, reports, correspondence, bills, orders, instructions, specifications, checks and the many other purposes for which papers serve as the medium for business transactions. While effort is constantly directed toward reducing paper work to the minimum consistent with orderly operation, Bell System requirements for this class of papers amount to over 5,000,000 pounds annually—equivalent to more than five hundred million letter-size sheets.

So vast a quantity of papers presents many problems in the selection of those best suited to telephone company needs from the great variety commercially available; in the adaptation of those selected to the numerous particular purposes for which papers of this kind are used; and in the establishment of the most advantageous supply arrangements.

The first attempts to meet these problems were begun in 1917. The Western Electric Company, in performing its function of establishing centralized supply arrangements whenever these could be carried out to the best interest of the service, had entered into contracts to centralize the purchasing of the bulk of printed business papers for two of the Associated Companies. While this procedure offered some measure of economy over the general practice of dealing with a number of supply sources and of handling each printed form as an individual transaction, it left much to be desired. The forms required were listed under these early contracts and individually priced according to the judgment of each contractor submitting a bid. The one

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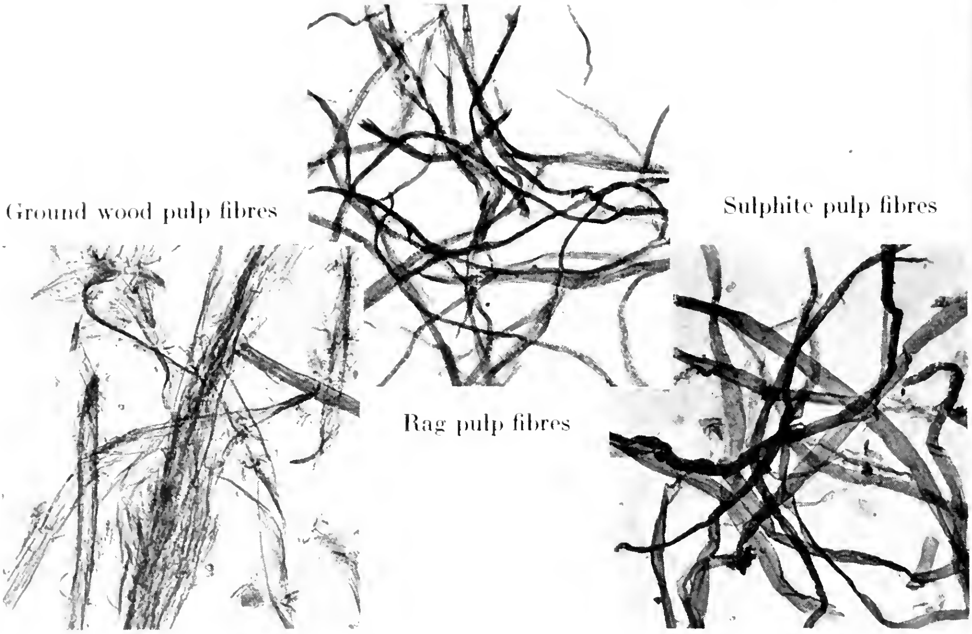
* "Directory Paper Purchasing," QUARTERLY, April, 1939.



Ground wood pulp fibres

Rag pulp fibres

Sulphite pulp fibres

PHOTOGRAPHS FROM U. S. TESTING CO., INC., HOBOKEN, N. J.

THREE PRINCIPAL PAPER PULP FIBRES

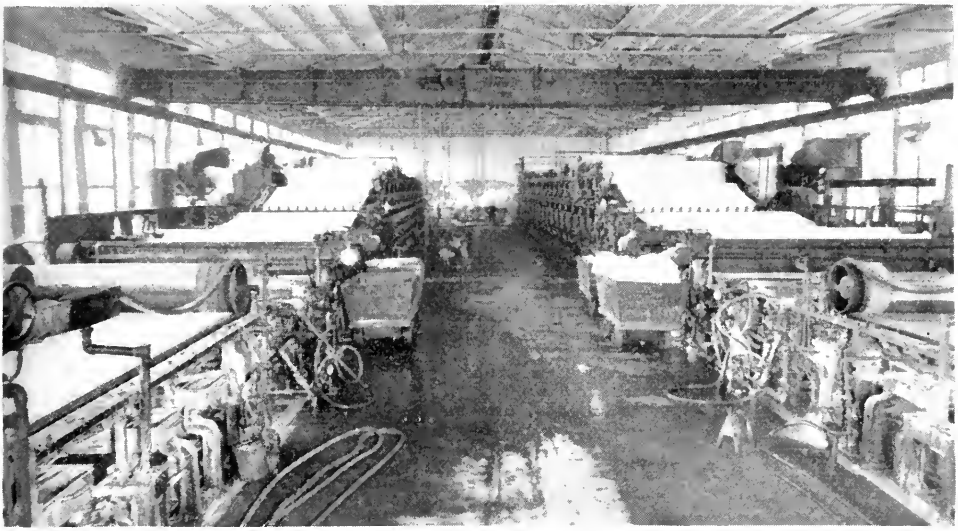
These photomicrographs represent a magnification of approximately 100 diameters

whose total bid was lowest received the business, although for any particular form his price might be higher than other bidders.

In all of these negotiations, paper was a constant source of difficulty. Numerous brands were specified, many of which the printer did not normally carry in stock, and the question of substitution would necessarily arise. Inasmuch as there were hundreds of forms, on papers of many different sizes, weights, and colors, substitution only led to confusion and to the question of whether the substitutions offered by one bidder were the equal in quality of the substitutions offered by another. This difficulty was magnified by the fact that little definite data as to paper quality were generally available.

A further complication developed in the rapid increases in paper prices during the war period. The printer could not control the cost of paper to nearly the same extent to which he could control the cost of his printing and binding, which were under his own supervision. As paper prices went up, the cost of the finished product went up also; and in order to save the contractor from serious losses, price increases were granted which might or might not have been less than a competitor would have asked. The contracts, accordingly, lost much of their advantage.

It was evident that development of a new procedure was necessary. The



FOURDRINIER MACHINES

Paper starts as a thin solution of pulp and water at the "wet" end of these huge affairs, in the foreground, is screened, dried, pressed, and ironed on the way, and reaches the distant end as a finished product

objective would be to establish a range of standard papers of suitable quality for all requirements. These would then be supplied to the printer at definite prices, in order to relieve him of the burden of the paper problem as to both purchasing and quality. Under this plan, the printers, in submitting their bids for a telephone company's business paper requirements, would be concerned only with those elements of cost over which they exercised control.

Enter the A. T. & T. Engineers

THE American Telephone and Telegraph Company was asked to undertake this work, along with its other standardization activities.

At the time the A. T. and T. Company undertook standardization, information for consumer judgment of quality in business papers was indeed meager. Papers were generally sold on a brand basis. Specifications accurately defining strength, wearing qualities, and other characteristics of the types of papers used for business purposes were little used as a basis of purchase.

Testing by consumers was infrequent and, if they wished to make tests, few instruments were to be had. The usual complement of physical testing equipment consisted of the Mullen or "pop" tester, for measuring the bursting strength of paper by breaking a hole through a sheet, a weighing scale, and a micrometer. Buyers would do some "practical" testing by tearing a sheet of paper in several directions, by feeling and rattling it, and even by chewing a small piece. What the last disclosed has not been passed on to us. Experience was the principal guide, and one not infrequently upset when a manufacturer elected to change the quality of a particular brand during the course of time or even to discontinue it.

The A. T. and T. engineers decided to establish a range of standard papers adequate for telephone needs, according to basic types. They found that an adequate range was available among the regular commercial grades and concluded that, despite volume sufficient to justify manufacture of special grades, this procedure should be avoided. To ensure that they were fully informed regarding all available grades, they visited paper mills manufacturing qualities varying from the poorest to the best.

Paper and Paper Making

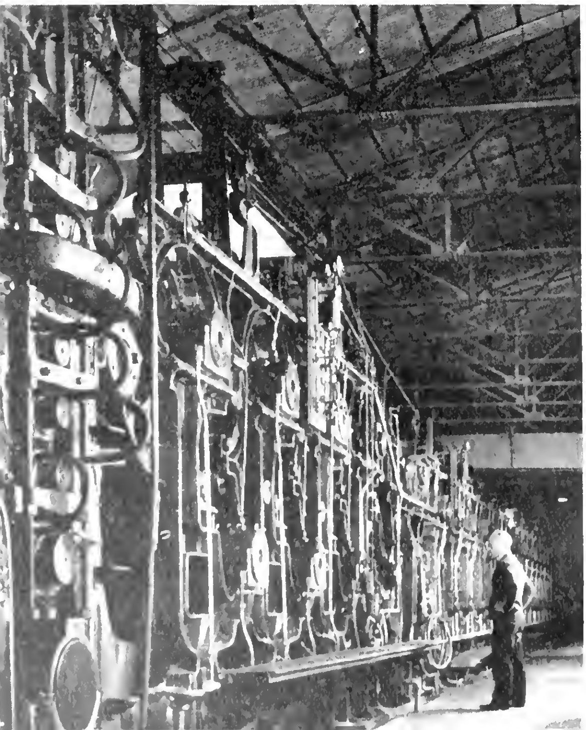
Paper manufacturing processes are generally similar and, in so far as broad principles are concerned, relatively simple. Paper is basically cellulose fibre, obtained principally from wood and from cotton rags. The wood or rags are reduced to pulp to which a small amount of sizing material is added, consisting of rosin, glue or starch to serve as a binder. Proportions of clay and others fillers are added also to improve opacity and finish. Spruce and pine are the lowest-cost sources of cellulose and are, accordingly, the principal raw material.

For ground wood pulp, which is the major component of newsprint and of many stationers' papers, the wood is debarked, knots are removed, and it is then ground against a stone in the presence of water, to shred the fibres apart. This method of pulp manufacture is the least expensive, but it is also rather drastic and the pulp is weaker and less permanent than that produced by chemical processing, which is employed for the better grades.

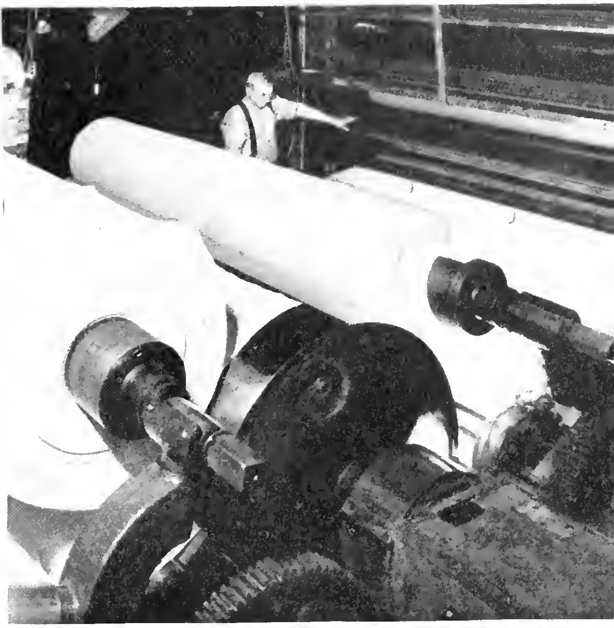
The chemical processes consist of reducing the wood to chips and boiling these for a number of hours with either an acid or alkaline solution, depending upon the characteristics desired in the pulp—to free the fibres by cooking out the resins binding them together. Chemical pulps are bleached to obtain a better white. Bleaching reduces fibre strength to some degree but it also imparts greater permanence by producing a purer cellulose.

When rags are used as raw material, they are cut into small pieces, cooked with alkali and then bleached.

After the pulp is conditioned, it is mixed with great quantities of water and then flows as a thin solution onto the traveling screen of a huge papermaking machine which dries, presses, and irons the pulp before it is transferred to a roll as finished paper.



The "dry" end of a Fourdrinier machine



The final step: winding the finished product on reels

An important and interesting phase of paper making, from the standpoint of paper standardization, is the compounding of pulps to produce papers of various characteristics. Each pulp has qualities that are reflected in the strength, permanence, opacity, etc., of the finished product.

Ground wood or mechanical pulp, as it is also called, is low in cost, has high opacity, limited strength, and limited permanence; qualities which make it suitable for newsprint and for many business purposes when the usage is large and paper of low strength and permanence is satisfactory. A great quantity of paper composed principally of ground wood is employed in the Bell System for tickets to record telephone calls, the consumption exceeding a million and a quarter pounds annually.

Chemical pulps are of three classes: sulphite, sulphate, and soda, the latter manufactured from deciduous woods such as poplar and birch. Papers made from sulphite pulp comprise the great majority of business stationery. It produces a paper of good appearance and wearing qualities at moderate cost. Sulphate pulp makes our brown wrapping paper. It is a stronger fibre than sulphite and is moderate in cost, but because of the brown color its use for business papers is largely confined to envelopes and file folders. Soda pulp is employed only in combination with others. It has little strength but is opaque and finds use where papers having bulk and opacity are required. It is commonly found in combination with sulphite pulp in envelope stocks.

Rag pulp produces papers of the highest grade. They have the greatest strength and resistance to erasure, but are also the most costly. Rag papers are employed for permanent records, ledgers, and other purposes requiring maximum durability and appearance.

The usual combinations of pulps are: ground wood and sulphite; ground wood, sulphite, and soda; sulphite and soda; sulphite and rag. The finished paper bears the characteristic of the pulps of which it is composed in ratio to the proportions used.

Establishing a Standard Range

Upon completion by the A. T. and T. engineers of their review of the manufacturing and technical aspects of the standardization job, the papers in use by the Associated Companies were analyzed for pulp composition, and were tested for strength and other physical characteristics in so far as the limited equipment available at that time permitted. The result of all this work was a thorough acquaintance with both the technology of the available grades of business papers and with the kinds of papers required by the telephone companies.

Combining the technical information, on the one hand, with the usage requirements, on the other, made possible the establishment of a standard range of papers for the Bell System. Originally thirteen grades were set up. They ranged from a low cost paper, composed of ground wood and sulphite pulps, for temporary use forms, to 100 per cent rag papers for permanent record purposes. This list has been revised and expanded during the past 20 years, in pace with the changing requirements of the telephone companies and with the technical developments in papers, until today there are 23 standard grades. The chart on page 146 lists nineteen of the most widely used standards.

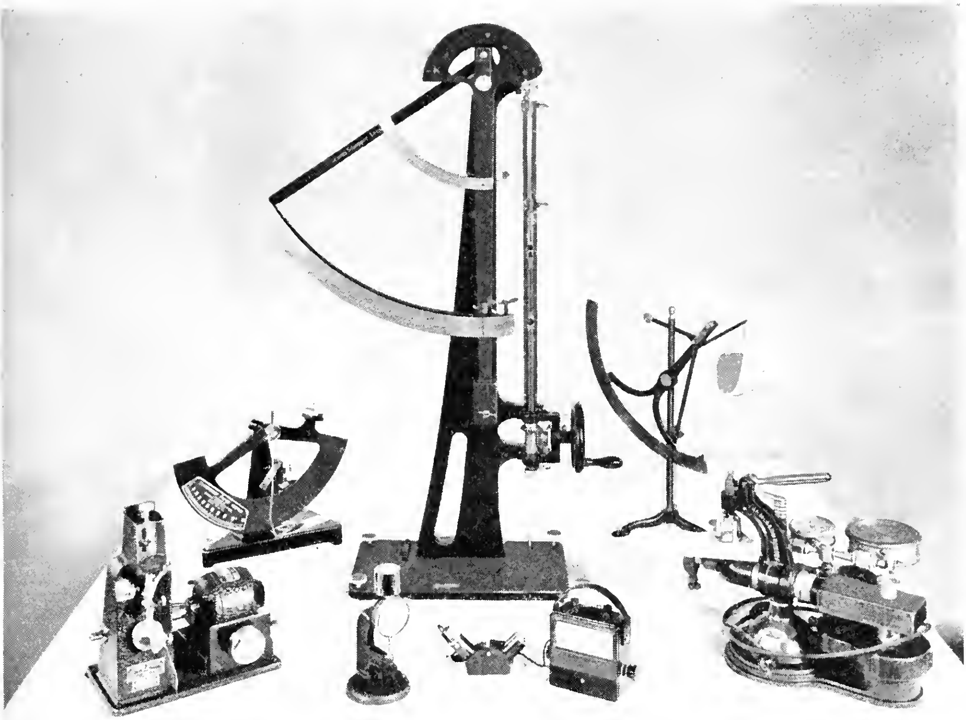
Advances in Technique

When the original thirteen grades were selected, specifications in the form of standard samples were established for each grade. At the time, the standard sample was the nearest approach that could be made to definite specifications, and while data on composition and physical characteristics were developed, it was most practical to buy by sample.

Several conditions contributed to this situation. Raw material and manufacturing control was such that paper made on one day was not necessarily equal in all respects to paper made on the day following, so that considerable tolerance in quality had to be allowed. Paper strength, particularly with respect to tearing and folding, is subject to wide fluctuation with changes of humidity, and a paper that might pass specification requirements on a humid day in summer might fail badly on a cold day in winter when the relative humidity in the laboratory was very low. Air-conditioned laboratories were extremely few at that time, and very expensive. Specifications are normally established on the basis of minimum requirements, but to set them sufficiently low to cover the worst conditions would have resulted in an inadequate definition of grades. The sample basis was accordingly decided on.

Many instruments for the testing of papers have since come into wide use by the paper industry and by independent laboratories, and testing laboratories are conditioned to a definite temperature and humidity. The instruments include devices for measuring opacity, brightness, light reflection, tearing, folding and tensile strengths, smoothness, stiffness, acidity, and degree of permanence. A group of these instruments is shown on the opposite page.

Substantial advances have likewise been made in the technology of paper manufacture and in the design of equipment to control better the processing operations to produce paper of more uniform quality. These developments have recently permitted the preparation of written specifications for the purchase of paper, defining the standard grades in terms of specific test requirements covering composition, strength, opacity, finish, etc. It is no longer necessary for the Western Electric Company, in its purchasing and delivery inspection work, to depend entirely on samples, which may deteriorate in storage to the extent of failing to represent the qualities desired.



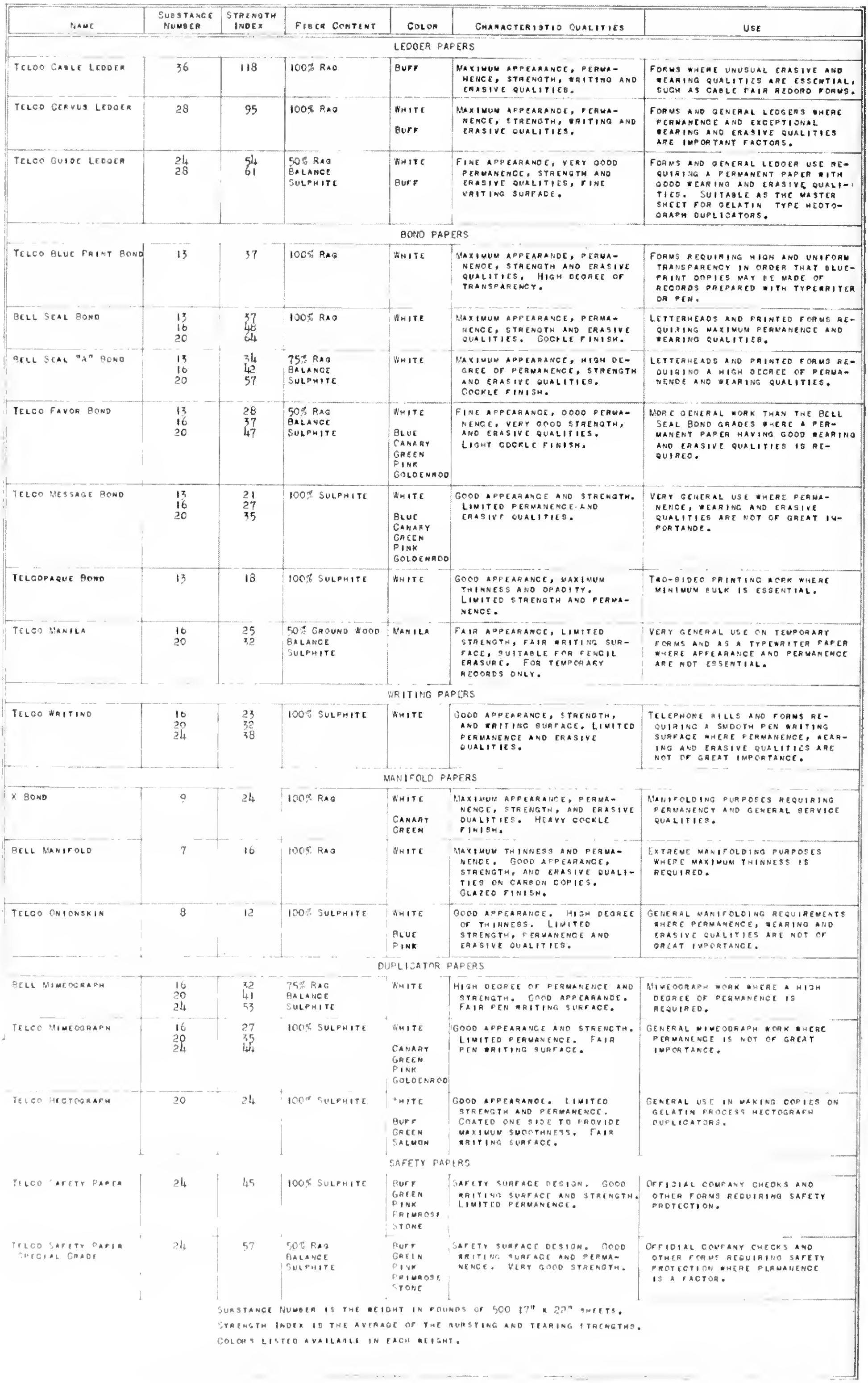
PAPER TESTING INSTRUMENTS

Shown here are some of the devices used in establishing and maintaining the desired standards for Bell System business papers

When paper standardization had been completed, the A. T. and T. engineers were ready to assist the Associated Companies in converting their plain and printed papers to the standard grades. The possibilities of effecting economies in printing as well as in paper were developed by the technical men in the course of their investigations regarding qualities of paper necessary for satisfactory printing. These pertained to the many features of form design that contribute to printing economy. Since approximately 75 per cent of all stationery papers used by the Bell System are converted to printed forms, the potentialities for savings on this phase of the work were substantial.

Aiding the Bell Companies

THE telephone companies naturally welcomed expert assistance in the survey of their business papers. All of the many plain papers and all of the hundreds of printed forms required by each company to carry on its business in an orderly manner were systematically reviewed. The standard grades were substituted for papers in current use, with particular attention directed to whether the grade employed was most suitable in each case. If not, a change to another grade was specified.



Name	Substance Number	Strength Index	Fiber Content	Color	Characteristic Qualities	Use
LEDGER PAPERS						
Telco Cable Ledger	36	118	100% Rag	Buff	Maximum appearance, permanence, strength, writing and erasive qualities.	Forms where unusual erasive and wearing qualities are essential, such as cable pair record forms.
Telco Cervus Ledger	28	95	100% Rag	White Buff	Maximum appearance, permanence, strength, writing and erasive qualities.	Forms and general ledgers where permanence and exceptional wearing and erasive qualities are important factors.
Telco Guide Ledger	24 28	54 61	50% Rag Balance Sulphite	White Buff	Fine appearance, very good permanence, strength and erasive qualities, fine writing surface.	Forms and general ledger use requiring a permanent paper with good wearing and erasive qualities. Suitable as the master sheet for gelatin type hectograph duplicators.
BOND PAPERS						
Telco Blue Print Bond	13	37	100% Rag	White	Maximum appearance, permanence, strength and erasive qualities. High degree of transparency.	Forms requiring high and uniform transparency in order that blueprint copies may be made of records prepared with typewriter or pen.
Bell Seal Bond	13 16 20	37 48 64	100% Rag	White	Maximum appearance, permanence, strength and erasive qualities. Cockle finish.	Letterheads and printed forms requiring maximum permanence and wearing qualities.
Bell Seal "A" Bond	13 16 20	34 42 57	75% Rag Balance Sulphite	White	Maximum appearance, high degree of permanence, strength and erasive qualities. Cockle finish.	Letterheads and printed forms requiring a high degree of permanence and wearing qualities.
Telco Favor Bond	13 16 20	28 37 47	50% Rag Balance Sulphite	White Blue Canary Green Pink Goldenrod	Fine appearance, good permanence, very good strength, and erasive qualities. Light cockle finish.	More general work than the Bell Seal Bond grades where a permanent paper having good wearing and erasive qualities is required.
Telco Message Bond	13 16 20	21 27 35	100% Sulphite	White Blue Canary Green Pink Goldenrod	Good appearance and strength. Limited permanence and erasive qualities.	Very general use where permanence, wearing and erasive qualities are not of great importance.
Telcopaque Bond	13	18	100% Sulphite	White	Good appearance, maximum thinness and opacity. Limited strength and permanence.	Two-sided printing work where minimum bulk is essential.
Telco Manila	16 20	25 32	50% Ground Wood Balance Sulphite	Manila	Fair appearance, limited strength, fair writing surface, suitable for pencil erasure. For temporary records only.	Very general use on temporary forms and as a typewriter paper where appearance and permanence are not essential.
WRITING PAPERS						
Telco Writing	16 20 24	23 32 38	100% Sulphite	White	Good appearance, strength, and writing surface. Limited permanence and erasive qualities.	Telephone bills and forms requiring a smooth pen writing surface where permanence, wearing and erasive qualities are not of great importance.
MANIFOLD PAPERS						
X Bond	9	24	100% Rag	White Canary Green	Maximum appearance, permanence, strength, and erasive qualities. Heavy cockle finish.	Manifolding purposes requiring permanency and general service qualities.
Bell Manifold	7	16	100% Rag	White	Maximum thinness and permanence. Good appearance, strength, and erasive qualities on carbon copies. Glazed finish.	Extreme manifolding purposes where maximum thinness is required.
Telco Onionskin	8	12	100% Sulphite	White Blue Pink	Good appearance. High degree of thinness. Limited strength, permanence and erasive qualities.	General manifolding requirements where permanence, wearing and erasive qualities are not of great importance.
DUPLICATOR PAPERS						
Bell Mimeograph	16 20 24	32 41 53	75% Rag Balance Sulphite	White	High degree of permanence and strength. Good appearance. Fair pen writing surface.	Mimeograph work where a high degree of permanence is required.
Telco Mimeograph	16 20 24	27 35 44	100% Sulphite	White Canary Green Pink Goldenrod	Good appearance and strength. Limited permanence. Fair pen writing surface.	General mimeograph work where permanence is not of great importance.
Telco Hectograph	20	24	100% Sulphite	White Buff Green Salmon	Good appearance. Limited strength and permanence. Coated one side to provide maximum smoothness. Fair writing surface.	General use in making copies on gelatin process hectograph duplicators.
SAFETY PAPERS						
Telco Safety Paper	24	45	100% Sulphite	Buff Green Pink Primrose Stone	Safety surface design. Good writing surface and strength. Limited permanence.	Official company checks and other forms requiring safety protection.
Telco Safety Paper Special Grade	24	57	50% Rag Balance Sulphite	Buff Green Pink Primrose Stone	Safety surface design. Good writing surface and permanence. Very good strength.	Official company checks and other forms requiring safety protection where permanence is a factor.

Substance Number is the weight in pounds of 500 17" x 22" sheets.

Strength Index is the average of the bursting and tearing strengths.

Colors listed available in each weight.

SYSTEM STANDARD

Chart of the 19 standardized grades of business papers most used in the Bell System

Forms or plain papers that did not cut economically from standard ream-size sheets were changed, as far as practical, to sizes that would. There are a number of mill standard ream sizes for business papers, the most common being 22 x 34 inches. Eight letter-size sheets 8½ x 11 inches will cut exactly from this standard size; but if the plain paper or form were 9¾ x 12½ inches, only four could be cut from the mill size. The remainder is waste which must be included in the price of the finished product.

Odd sizes in forms often come about because they are designed from the inside out rather than the outside in; that is, the designer will draw the form and let over-all dimensions come as they will, rather than first approximating the size, selecting the nearest multiple of a standard ream size, and then designing the form within it. From the attention to size, not only more economical but also more practical and better looking forms have resulted.

THE use of colored papers to designate the second, third or fourth copies of forms and for other purposes was minimized in the surveys because, if used too widely, colors lose their significance: pink may have a certain significance with respect to one form but quite a different meaning in the case of another. Colors also add to the cost; for example, a form made up of four copies, each of a distinguishing color, involves extra expense for printing, since each must be run separately and then collated into sets.

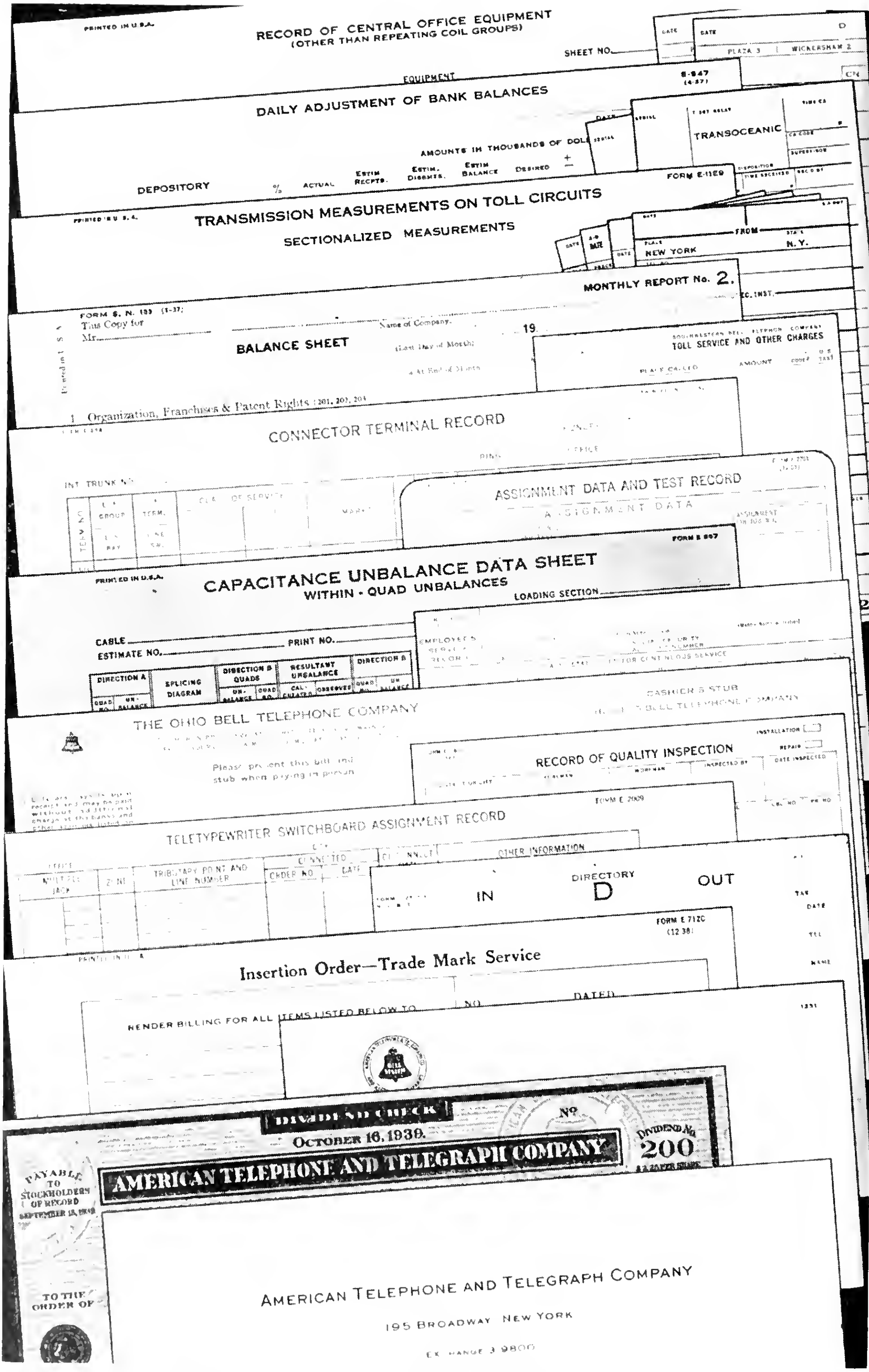
It was sometimes found that separate copies of forms bore minor differences in printing. As far as the printer was concerned, each copy represented a different job, and the important factor of quantity in printing economy was diminished by these minor differences. Other items contributing to extra expense of forms were eliminated as far as practical, such as two color printing, printing on both sides of a sheet, numbering, perforating, and others.

Centralized Purchasing

AS each form was reviewed, specifications were established to cover the usage, size, grade of standard paper, color of ink, punching, binding, etc. With this information set up, the ground work was laid for the Western Electric Company to take up again its plan for centralized buying of business papers in the performance of its function as the service of supply for the Bell System.

Coincident with the surveys of each company's business papers, the Western Electric Company had set up supply arrangements for the standard paper grades. These permitted it to furnish the printers with papers of certain standards of quality at definite prices. The printers were thus relieved of responsibility for both paper cost and quality, which had been primary obstacles in the earlier attempts at establishing satisfactory central supply arrangements.

As each survey was completed and specifications were drawn up for all stationery forms, the Western Electric Company buyer stepped into the picture to negotiate with the printers. One of the first questions presented was the handling of the composition for each form. Setting a form in type,



PRINTED IN U.S.A.

RECORD OF CENTRAL OFFICE EQUIPMENT
(OTHER THAN REPEATING COIL GROUPS)

SHEET NO.

EQUIPMENT

PLAZA 3 WICKERSHAM 2

E-947
(4-37)

DAILY ADJUSTMENT OF BANK BALANCES

AMOUNTS IN THOUSANDS OF DOLLARS

DEPOSITORY % ACTUAL ESTIM. RECPTS. ESTIM. DISBMTS. ESTIM. BALANCE DESIRED

TRANSOCEANIC

FORM E-1129

PRINTED IN U.S.A.

TRANSMISSION MEASUREMENTS ON TOLL CIRCUITS
SECTIONALIZED MEASUREMENTS

FROM
NEW YORK N.Y.

MONTHLY REPORT No. 2.

FORM S. N. 133 (1-37)
This Copy for
Mr.
Name of Company. 19
BALANCE SHEET
(Last Day of Month)
1 Organization, Franchises & Patent Rights (201, 202, 204

SOUTHWESTERN BELL TELEPHONE COMPANY
TOLL SERVICE AND OTHER CHARGES
PLACE CALLED AMOUNT

CONNECTOR TERMINAL RECORD

INT. TRUNK NO.

ASSIGNMENT DATA AND TEST RECORD
ASSIGNMENT DATA

FORM E 997

PRINTED IN U.S.A.

CAPACITANCE UNBALANCE DATA SHEET
WITHIN - QUAD UNBALANCES

LOADING SECTION

CABLE PRINT NO.
ESTIMATE NO.

DIRECTION A	SPLICING DIAGRAM	DIRECTION B QUADS	RESULTANT UNBALANCE	DIRECTION B

EMPLOYEES SERVICE RECORD

CASHIER'S STUB

THE OHIO BELL TELEPHONE COMPANY

Please present this bill and stub when paying in person

RECORD OF QUALITY INSPECTION

INSTALLATION ☐ REPAIR ☐

FORM E 2909

TELETYPEWRITER SWITCHBOARD ASSIGNMENT RECORD

OTHER INFORMATION

IN DIRECTORY D OUT

FORM E 712C
(12-38)

Insertion Order—Trade Mark Service

NO. DATED

RENDER BILLING FOR ALL ITEMS LISTED BELOW TO

DIVIDEND CHECK

OCTOBER 16, 1939.

No

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

DIVIDEND No. 200

PAYABLE TO STOCKHOLDERS OF RECORD SEPTEMBER 15, 1939

TO THE ORDER OF

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

195 BROADWAY NEW YORK

EXCHANGE 3-9800

SOME TYPICAL SYSTEM BUSINESS PAPERS

These and hundreds of others are printed on stocks and to specifications described in the accompanying article or ruling it in wax in order to make an electrotype plate for printing the form, is a basic expense which applies regardless of the number of copies to be printed. With the hundreds of forms involved, the total cost for composition represents a substantial sum.

In order to protect this investment, it was decided to produce a master plate, for a small additional cost, which was set aside as the telephone company's property. The printer was permitted to prepare his printing plates from the master and to use it for replacing plates that became worn or damaged. Telephone company ownership of the master plates also facilitated competition in arranging contracts, for otherwise a new printer would have to reset all composition in order to make printing plates for his own presses—a handicap that would practically preclude a successful bid.

Establishing Authorized Stocks

It will be recalled that, in making up specifications for each form, usage was included. In the case of forms having a continuing demand—the great majority—this represented annual usage. Based upon this figure, definite stocks were determined upon, which the printer was authorized to establish and maintain during the life of his contract. These were called authorized stocks. They were intended to assure prompt service to the telephone company and to give the printer the equivalent of standing orders which he could use in arranging manufacturing schedules for most economical production.

Since the authorized stocks established the manufacturing quantities, they also established the quantity upon which the price of each form was based. The stocks were normally set to last three to four months, although for forms of limited use, where the small quantity might involve excessive printing costs, the stocks were for longer periods. The authorized stocks permitted the printer to level his production, and to keep his organization busy replenishing the telephone company's withdrawals at times when his business from other sources was slack. The stocks were drawn on by the telephone company as required.

The plan of having standard papers, specifications for each form, master plates, and authorized stocks, met with considerable favor among printers. Opportunities were afforded for savings in manufacture which were reflected in the bids submitted by the printers to the Western Electric Company's buyer, and very substantial reductions in the cost of business papers to the telephone companies resulted.

Purchase arrangements have undergone simplification over the years, until today printing for Bell System business papers is purchased literally on a square-inch basis. The specifications continue to be used, a little more inclusive perhaps, but essentially the same, including a price for each individual form.

The price for printing each form, however, is based on its square-inch area. In submitting bids, the printer establishes his printing prices, or press work schedule as it is called in the trade, in tabular arrangement according to square-inch area and quantity to be printed. The table shows that a form of 100 square inches in 5000 quantity costs one price, in 10,000 quantity another, etc. Composition and electrotype plate charges are also set at flat rates per square inch. Paper is priced on a pound basis, as formerly, according to the maximum number of cuts obtained from standard size sheets.

DEFINITE scales of prices are established for other operations, including padding, collating, punching, binding, etc. This procedure greatly simplifies pricing of existing forms and permits immediate pricing of most new ones. It eliminates entirely the tedious task under the old contracts of pricing each form individually, or at the same figure as another of the same size, quantity, style, and paper quality. Lithographic or offset printing has also come into general use as a supplement to type printing, especially for the reproduction of statistical charts and of material prepared by typewriter.

The plan for simplifying paper requirements by standardizing an adequate range of grades, for the elimination of costly and frequently non-essential printing operations, and for centralized supply arrangements has resulted in a very material reduction in the cost of business papers to the Bell System—cost representing an annual expense of several million dollars.

Formerly, the hundreds of forms used constituted hundreds of separate problems and purchase transactions for each telephone company. Today the problem has been reduced to the review of a chart for paper selection and to the review of specific instructions for the economical design of forms from a printing standpoint. The Western Electric Company has reduced purchasing to the arrangement of a contract covering a period of one year or more for each company.

In addition to the very substantial monetary savings, there is the assurance that the paper grades used are those best suited to the requirements, and, equally noteworthy, there is an immense saving of time through this more efficient and orderly procedure for seller, buyer, and consumer.

MUCH has been accomplished. It would appear that another story of what coöperation and the persistent pursuit of a clear-cut objective can accomplish is ended. But not so; for continued study is made of possible changes in the plans described, to effect further simplification and economy. As improvements are brought about, they have served as the vantage point from which to look beyond present horizons to future opportunities for progress through the coöperative effort of all concerned.

FOR THE RECORD

LEWIS H. BROWN ELECTED A DIRECTOR

At the meeting of the Board of Directors of the A. T. and T. Company on February 21, Lewis H. Brown, president of the Johns-Manville Corporation, was elected a director, to fill the vacancy caused by the death of Philip Stockton. Mr. Stockton, who died on February 11, had been a director since 1914. Mr. Brown, who was elected to the Johns-Manville presidency in 1929, has served on many committees interested in civic and national affairs, and was for several years a director of the New York Telephone Company.

REDUCTIONS IN CERTAIN LONG DISTANCE RATES

Reductions in Long Lines Department rates to points in this country more than 420 miles distant, which will become effective May 1, will save the public an estimated $5,300,000 annually. These reductions were the result of negotiations with the Federal Communications Commission, which had instituted an inquiry as to possible reductions in long distance telephone rates. The following examples are typical:

	Initial Three-Minute Period							
	Station-to-Station				Person-to-Person			
	Day		Night and Sunday		Day		Night and Sunday	
	Present Rate	New Rate	Present Rate	New Rate	Present Rate	New Rate	Present Rate	New Rate
Chicago-Washington	$1.85	$1.65	$1.15	$1.10	$2.45	$2.20	$1.75	$1.65
Boston-Chicago	2.50	2.10	1.50	1.40	3.25	2.80	2.25	2.10
Oklahoma City-New York	3.75	2.90	2.25	1.95	4.75	3.85	3.25	2.90
Chicago-Los Angeles	4.75	3.50	3.25	2.50	6.25	4.50	4.75	3.50
New York-San Francisco	6.50	4.00	4.25	3.00	8.75	5.00	6.50	4.00

DEMONSTRATION OF STEREOPHONIC REPRODUCTION OF MUSIC

The stereophonic reproduction of "enhanced" music was demonstrated to distinguished audiences in Carnegie Hall, New York City, on April 9 and 10 by the Bell Telephone Laboratories. There for the first time was shown the possibility of recording and reproducing every sound of a program which the ear could have heard at the original performance.

Listeners had the same spatial sense of the source of the music as if they had been present in the hall at the time of recording and, in addition, heard the music enhanced according to the original director's interpretation of tone and volume.

This accomplishment is the culmination of a long series of researches by the Laboratories. As long ago as 1933 a symphony concert produced in Philadelphia was transmitted over telephone wires to Washington and there reproduced stereophonically before the National Academy of Sciences. Subsequent research has supplied the equipment and technique for recording music without loss and with an actual enhancement of its artistic feeling.

With the coöperation of Leopold Stokowski and the Philadelphia Orchestra, of the Tabernacle Choir and organists in Salt Lake City, and of Paul Robeson and other artists, scientists of the Bell Telephone Laboratories under the direction of Dr. Harvey Fletcher first recorded their music or drama either in Philadelphia or in Salt Lake City. At a later audition the artist or director was able to vary the recorded volume and to change the tonal color of the music to suit his taste. At will, he could soften it to the faintest pianissimo or amplify it to a volume ten times that of any orchestra without at all altering its tone quality, or he might choose to augment or reduce the high or low pitches independently. While he was thus enhancing the music which he had himself produced, his interpretation was being re-recorded on film as a permanent record. Records so produced were played at Carnegie Hall.

The technique worked out by Dr. Fletcher and his associates picks up the original sounds through three microphones, placed respectively at right, center, and left of the stage. Sound currents from each microphone are amplified, and are recorded on separate sound tracks on a moving film.

Since an orchestra or an organ has a range of loudness very much greater than can be recorded without distortion on a photographic film, it is necessary to "compress" the original range of sounds before recording. On a fourth track, account is kept of the amount of compression, as an automatic control for the "expansion" of volume range which must be made in reproduction.

When the film is run through the reproducer, three separate sound currents are created. Each sound current actuates its own set of loud speakers, located at right, center and left of the stage. This arrangement, together with the wide frequency and volume range of the system, gives to the music spatial and emotional values heretofore unknown either in reproduced or original productions.

From the choral numbers, vocal solos, organ, drama, and grand opera reproduced in Carnegie Hall, the audience gained an idea of the versatility of the stereophonic system. This first part of the program was climaxed by the closing scene from "Götterdämmerung." For its fortissimo passages, Dr. Stokowski took full advantage of the tenfold increase of sound over that of the largest orchestra, and used effectively the individual controls to make the soloist's voice clearly heard above the orchestra. That number, and orchestral works by Bach, Debussy, Strauss and Moussorgsky which formed the second part of the program, were played by the Philadelphia Orchestra under Dr. Stokowski's baton. In his enhancements, he has shown a grasp of the possibilities of the stereophonic system which comes from his long association with it and from his interest in this development of the musical art.

CONTRIBUTORS TO THIS ISSUE

Graduated from Dartmouth College with the B.A. degree in 1909, **Harold M. Prescott** entered the Bell System two years later as a traffic student with the Pacific Telephone and Telegraph Company at Los Angeles. He was engaged in traffic work on the Pacific Coast for 17 years; from 1919 to 1925 he was General Toll Supervisor, and Division Traffic Manager from 1925 to 1928. In the latter year he transferred to the A. T. and T. Company as head of the central office results group in the Department of Operation and Engineering. In 1929 he became Traffic Results Engineer, and on January 1 of this year was appointed Traffic Engineer. The development of a more personal and pleasing service, through such means as are described in his article, has been one of his special interests for a number of years.

Bates College graduated **Robert L. Tomblen** with the degree of B.A. in 1914, and Worcester Polytechnic Institute with the degree of B.S. in E.E. in 1917. He joined the Long Lines Department of the A. T. and T. Company in July of the latter year as a student in traffic engineering, but left for military service in September. After 19 months of army duty in this country and overseas he rejoined the A. T. and T. Company in the Commercial Engineer's Division of the Department of Operation and Engineering. Here he was engaged for several years in making commercial surveys of some of the principal cities of the country. In 1929 he transferred to the Chief Statistician's Division of the Comptroller's Department, where he continued his market research and population studies. He is a member of the Population Association of America, and has contributed to the Quarterly several articles which analyzed the 1930 census data and related subjects.

Receiving the B.A. degree from Lafayette College in 1907, and the LL.B. degree from the New York Law School in 1909, **Robertson T. Barrett** practiced law until 1918, and for the next three years was engaged in newspaper work. In 1921 he joined the Information Department of the A. T. and T. Company, and since 1936 he has combined his duties in that department with those of Historical Librarian of the A. T. & T. Co. He is editor of the *Telephone Almanac*, and has contributed articles on a variety of topics to the Quarterly.

Following his graduation from the Sheffield Scientific School of Yale University in 1920 with the degree of Ph.B. in M.E., and a short period in another industry, **James J. Murphy** joined the A. T. and T. Company in the Department of Operation and Engineering in 1921. His work has included the standardization of numerous office supply items required in the telephone industry, of which his article on business papers is representative. In 1936 he was appointed supply specialist in the Plant Operation Division of the O. and E. Department, and is in charge of the group engaged on office and building supply standardization and on building operation matters.

BELL TELEPHONE QUARTERLY

OL. XIX JULY, 1940 NO. 3

MERICAN TELEPHONE & TELEGRAPH CO. • NEW YORK

BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

VOL. XIX JULY, 1940 NO. 3

Published in January, April, July and October for the
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THE THEODORE N. VAIL MEDAL FOR NOTEWORTHY PUBLIC SERVICE

TWO DECADES OF VAIL MEDAL AWARDS

They Perpetuate the Late Theodore N. Vail's Ideals, and Recognize Employees' Devotion to the Public Service, Through Bestowal of Medals for Outstanding Acts

By CHARLES J. SCHAEFER, JR.

Twenty years ago the death of Theodore N. Vail, who at that time was Chairman of the Board of Directors of the American Telephone and Telegraph Company, brought to a close the career of one of the outstanding figures in the development of the telephone in America. The Theodore N. Vail Memorial Fund was established soon thereafter to provide awards each year to telephone employees throughout the United States in recognition of noteworthy acts conspicuously illustrating the high ideals which governed Mr. Vail's policy of public service.

The Memorial in honor of Mr. Vail is administered by trustees on the basis of a broad concept of the telephone business. The awards for noteworthy acts and service of "employees of the Bell System" apply to all telephone workers engaged in the various agencies through which the System furnishes telephone service to the public. Thus it is that, in addition to awards to Bell telephone employees, a number of awards have been made over the years to employees of subsidiary and affiliated companies, connecting companies, agency offices, and private branch exchanges. Those charged with the administration of the Memorial not only have been trustees of the Fund itself but have also safeguarded the application of the Fund to the ideals and traditions on which it is founded.

To those familiar with the Bell System, these ideals are a continuing tradition of the business. Almost daily, among the more than 450,000 telephone workers in this country, acts are performed by employees which strikingly illustrate these ideals of service that go beyond the ordinary requirements of the job. As long recognized and often expressed, this thought of *service first* is more than devotion to an organization, inspiring as that may be. It derives from a sense of individual responsibility in the public service; it is a dedication to the highest ideals of duty and obligation in that service; it comes from intelligent recognition of the vital importance of telephone service in the lives of others and to the safety and well-being of the community; it is devotion to the whole telephone de-

This Certifies that the special award of a gold medal offered under the terms of the Theodore N. Vail Memorial Fund and known as the

THEODORE N. VAIL MEDAL

for Noteworthy Public Service

has been made to

Mildred Lothrop

Chief Operator, Homer, Nebraska.

For noteworthy public service, in the face of increasing personal danger and public disaster, displaying the highest courage, loyalty and devotion in saving human life.

After midnight of May 31, 1920, receiving word of an approaching flood, she took her place at the switchboard, warning the people to flee for safety and calling for help from the surrounding country, continuing her efforts until the rising water disabled the switchboard, when she barely escaped from the flooded building.

President

THE FIRST NATIONAL GOLD MEDAL AWARD CERTIFICATE

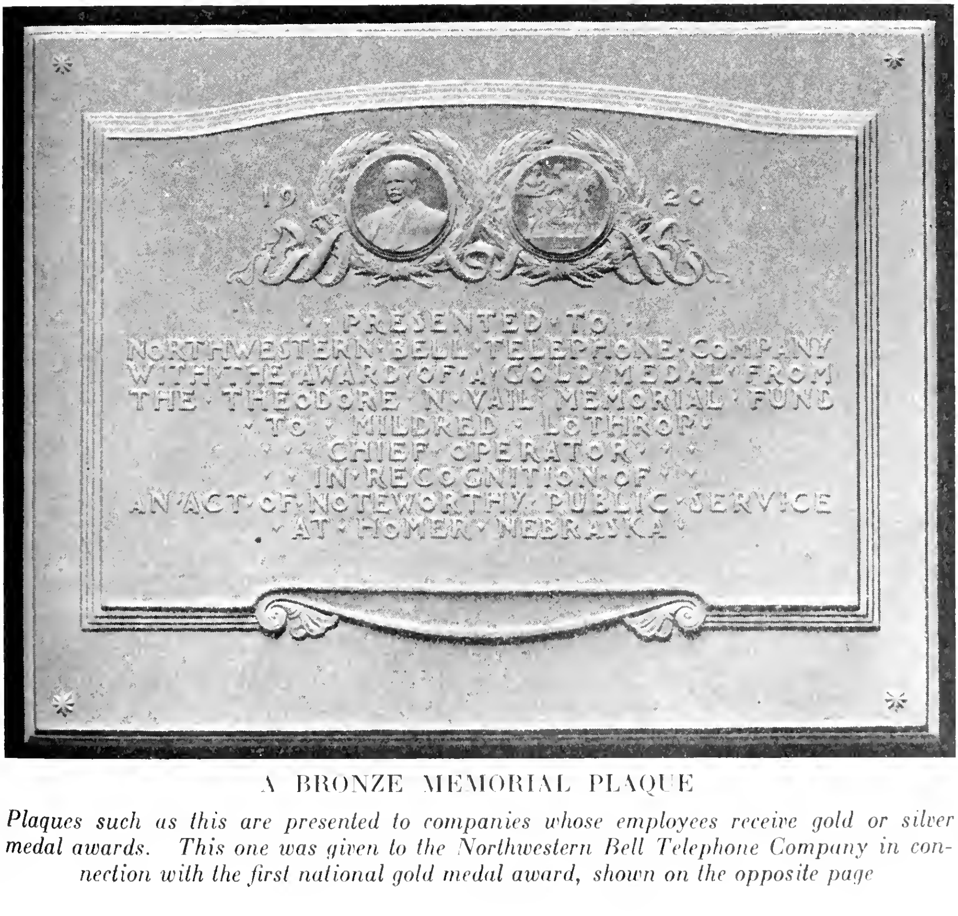
mocracy—to the thousands of fellow-employees whose coöperation, direct and indirect, makes individual accomplishment possible, and to the millions forming the telephone-using public who have built up their social and industrial fabric around and in reliance upon good telephone service.

Medals of Bronze, Silver, Gold

THE Memorial Fund provides a continuing plan for giving recognition to employees for acts of conspicuous service in emergencies through the award of bronze, silver, and gold medals, with accompanying citations. Cash awards of $250 are included in silver medal cases, and $500, or for a very exceptional act $1,000, in gold medal cases. In addition to these awards, bronze plaques are presented as a permanent and public memorial to the companies in which employees receive gold or silver medals, and special bronze plaques have been awarded in certain cases of noteworthy public service on the part of groups of employees where it was not possible to single out one or more persons for individual awards.

Committees of Award are appointed by the presidents of the Bell System Companies to consider all potential cases for award occurring each year within their respective territories, including cases of employees in subsidiary, affiliated, and connecting companies. After carefully reviewing each case, these Committees select the bronze medal award winners in their territories. These awards are then submitted to a Bell System Committee, appointed by the president of the American Telephone and Telegraph Company, which reviews them and any other cases which may be brought to its attention. Awards of gold or silver medals, and in some instances special plaques for groups, are made by the Bell System Committee in those cases which are considered to be of such conspicuous merit as to justify this higher recognition.

While telephone employees, like other citizens, often qualify for awards outside the Bell System, usually based on heroism or particular achievement, the Vail Medal Awards are distinctive in that the acts which they recognize are associated in some way with the telephone service, either by the use of telephone equipment or facilities or through training or experience gained in the telephone business. The usual elements which in varying degrees enter into the consideration of cases are initiative, re-



A BRONZE MEMORIAL PLAQUE

Plaques such as this are presented to companies whose employees receive gold or silver medal awards. This one was given to the Northwestern Bell Telephone Company in connection with the first national gold medal award, shown on the opposite page sourcefulness, courage, fortitude, and accomplishment. Some acts or services may include certain of these elements to an outstanding degree without being especially noteworthy with respect to other of these characteristics. However, there is usually a direct or indirect combination of most of these qualities in the higher awards.

Since the establishment of the Vail Memorial, awards have been made as follows:

VAIL MEDAL AWARDS TO EMPLOYEES

	Gold	Silver	Bronze	Total
Bell Associated Companies	8	78	966	1,052
Subsidiary Companies	1	3	5	9
Affiliated Companies	0	2	16	18
Connecting Companies	0	5	22	27
Private Branch Exchanges	2	0	1	3
Total	11	88	1,010	1,109

Of the above totals, there have been individual awards of gold medals to seven men and four women; silver medals to 49 men and 39 women; and bronze medals to 670 men and 285 women.

In addition to these individual awards, bronze medals have been awarded to 55 employee groups, from which 24 group cases have been selected for special bronze plaques in recognition of devotion to duty and outstanding achievement in maintaining vital telephone service or in the restoration of essential facilities in floods, earthquakes, and hurricanes involving widespread disasters.

Instances of Public Service for Which Awards Have Been Made

IT is, of course, impossible to include in an article of this length the many outstanding cases in which awards have been made over the past score of years. In view of the many different kinds of meritorious acts and the distinctive qualities of each, it is even difficult to select individual cases which give a comprehensive illustration of the general scope of the awards.

Such acts range from rendering important service to individuals in preventing or alleviating suffering to those related to widespread disasters in which vital communications, essential in saving lives and property and in effecting relief measures, were made possible by self-sacrificing devotion to duty. This is often accomplished in the face of extreme hazards by individual employees or by groups acting jointly in teamlike efforts. However, certain cases are cited below, without any attempt to distinguish relative merits with respect to the hundreds of other equally noteworthy cases, merely to typify these recurring acts for which the Vail Medal Awards provide deserved and lasting recognition.

HERE, for instance, is the case of a plant man in one of the Bell Companies which illustrates the spirit of service of those who build and maintain the lines.

A severe blizzard covered the entire state of Wyoming, from November 4 to November 8, 1922, causing breaks in the transcontinental telephone line west of Cheyenne. On the morning of November 7, the employee, although he was unfamiliar with the country west of Cheyenne, volunteered to go out ahead of the regular line crew and attempt to clear as much of the trouble as possible on the transcontinental line. The storm was still raging. Climbing poles, he worked along the line for eleven miles on foot before he was able to secure a horse from a ranch near that section of the line. He then was able to cover a total of thirty-five miles.

After being out in the storm for thirteen hours without food, he called the Cheyenne Wire Chief and was advised of another break in the line three miles farther along. The horse was exhausted and could go no farther, so the employee waded through deep snow until he reached the break, which he was able to repair, thereby completing through coast-to-coast service on the transcontinental line on the evening of a state election.

Returning, he found the horse, and then called the Wire Chief in Cheyenne, who advised him of an emergency shelter three miles from where he then was. He was finally successful in reaching this shelter about midnight. He put his horse in the stable and then, as he tried to break in the door of the bunk house, collapsed in the snow. Here he was found later and rescued by a fellow-employee. The Vail Memorial Award in this case was a gold medal and $500.

ANOTHER case, that of a chief operator in a midwestern city, is a manifestation of noteworthy public service on the part of the "weavers of speech."

While supervising an emergency call to the police shortly after 9:00 A.M., December 16, 1930, the chief operator overheard the report of a bank robbery. About the same time several calls came in from people in the vicinity of the bank, telling of the hold-up and that five bandits were fleeing in a northwesterly direction in an automobile. She immediately took a position at the switchboard and notified the sheriff and the police and civil authorities of all the towns located in the general direction taken by the bandit car. She gave a description of the car to subscribers throughout the countryside, many of whom had noted it speeding by. Thus she learned the exact route of the bandits. She kept in constant touch with all their movements, even though on various occasions the bandits commandeered other cars and changed their course, and quickly relayed all information to the authorities.

The original posse of two cars and eight men was quickly augmented by others closing in on the bandits from all directions, and the latter part of the chase was a running gun battle. The bandits were never able to break through the spreading circle of intelligence which the chief operator kept ahead of their flight. After a pursuit of more than 50 miles, and within two hours of the robbery, the posse surrounded the bandits in a barnyard and a large number of police and citizens engaged them in the final battle. Three bandits were killed and the other two captured, and the entire loot was recovered. The Vail Memorial Award was a silver medal and $250.

AN illustration of noteworthy public service on the part of large groups of employees is the splendid performance of Bell System people who contributed to the maintenance and restoration of service during and following the September 21, 1938, hurricane in the Northern Atlantic States.

This was the worst catastrophe ever to strike that area. In a brief few hours it took 682 lives and destroyed more than $500,000,000 worth of property. The Bell System suffered the greatest damage to outside plant and the largest number of service interruptions in its history. Approximately 600,000 telephones were silenced, and telephone damage amounted to about $10,000,000.

Confronted with this unparalleled test, the Bell System promptly mobilized its organized resources to meet the emergency. Large quantities of standardized materials for the vast job of reconstruction were swiftly made available, and trained employees from various parts of the Bell System quickly responded to the need by supplementing the efforts of their fellow-employees in the stricken area. Through their combined and untiring efforts, crippled plant was soon restored to service, emergency circuits were installed for public and relief purposes, and restoration was accomplished with skill, ingenuity, teamwork, unity of purpose, and courage.

A special bronze plaque was awarded for this self-sacrificing devotion to duty under most trying and difficult conditions. The inscription on the plaque is, in part, as follows:

IN RECOGNITION OF
LOYALTY, DEVOTION TO DUTY
AND ACHIEVEMENT

THE HURRICANE OF SEPTEMBER, 1938

THEIR MERITORIOUS ACTS
CONSPICUOUSLY EXEMPLIFY
THE HIGH IDEALS AND TRADITIONS
OF PUBLIC SERVICE

And so the story might be told of numerous other cases where those who operate and safeguard the channels of intelligence have unselfishly responded to emergency needs of humanity. It must be realized, however, that there are, in addition to these employees who have been selected for special recognition, thousands of their fellow-workers who daily do their part in less conspicuous but equally essential ways in rendering personalized service to society which exceeds the nominal call of duty. Such incidents are inherent in the business. The standing of a company, as measured by the quality of service, is dependent on the extent to which employees individually and collectively recognize that the company's traditions, policies, and accomplishments are their own and that the results attained reflect to the credit of each and the satisfaction of all.

Ideals of the Service

IT is this service feature of the "product" of the business which makes it more than an article having mere physical qualities and which has led to the opportunities for the kind of service exemplified by the Vail Medal Awards. Those who have had experience in telephone work realize that there is an *esprit de corps* which has been maintained in the business, despite enormous expansion and universal usage. The linemen and others who keep the wires alive in time of flood, fire, earthquake, and other disasters do not measure their efforts solely by the yardstick of material accomplishments in extending relief to

A SPECIAL GROUP AWARD

Plaques such as this are awarded in cases of especially noteworthy public service on the part of groups of employees where it is not possible to single out one or more persons for individual awards. This plaque was presented after the hurricane of September, 1938

stricken communities—they rise to the human needs of the occasion, and their traditional spirit of service is a most important element in the relief they render. The operators who, sometimes in the face of personal danger, give warning to save others, who instinctively offer urgently needed advice regarding aid or sources of assistance in emergencies, instil a spiritual value in the service far beyond that which is possible in the mere functioning of the inanimate instruments through which they work.

Because of these ideals of service, such efforts have sometimes led to the extreme sacrifice. The principals in such acts are truly heroic figures in the drama of life, who modestly effect their accomplishments with conspicuous courage and unselfish devotion to duty. It is these factors of service which make the telephone business more than a utility in its mechanical sense. Telephone employees are participating in rendering a service vital to the age in which we live; a service which, to be the best, must always include the finer human elements coöperating to maintain the splendid traditions of the business. The products of industry which have only physical qualities become obsolete and wear out; but real service to mankind is as enduring as time. So long as these fundamental facts are acknowledged by society, the Vail Memorial Fund will continue, in the years to come, its important purpose in giving permanent recognition to such outstanding acts of "noteworthy public service."

ANOTHER WAR GAME TEST OF BELL SYSTEM SERVICES

Effective Civilian Aircraft Warning Service Operated by Telephone in Five States, and Prompt Provision of Communication Facilities to Meet Military Needs, Aid Largest U. S. Army Maneuvers

By CLARENCE S. BOLEN

The part which telephone services played in the joint exercises of the U. S. Army Air Corps and Anti-Aircraft Artillery held in eastern North Carolina in October, 1938, and more particularly in the operation of the first "Civilian Aircraft Warning Service" during that period, was described in the Quarterly *for January, 1939, in an article entitled "A War Game Test of Telephone Service." The present article bears a closely similar title because, although the Army activities which it recounts were on a vastly greater scale, communications had a correspondingly important part in those maneuvers. Our readers will be interested, we feel, in this second account of the telephone industry's full coöperation with the field forces of the U. S. Army.*

Extensive activities of the United States Army, culminating in the largest peacetime maneuver ever held, provided the telephone companies along the Gulf of Mexico with an opportunity, during the period beginning May 5 and ending May 25, 1940, to demonstrate the efficiency of commercial telephone service in serving national defense needs.

Seventy thousand seasoned officers and soldiers, or about one-fourth of the total regular army, participated. Eastern Texas, the four southern congressional districts of Arkansas, the states of Louisiana, Mississippi, Alabama, western Florida and western Georgia were included in the territory covered by the make-believe war.

Featuring the military exercises, from the communications standpoint, was the preparation and operation of an "Aircraft Warning Service" in which civilian observers used long distance telephone service to report to a central point group flights of aircraft.

To the Army, the maneuvers were valuable in testing the organization of the new "streamlined" or "triangular" division in comparison with the old "square" division which was used during the World War; in testing the civilian aircraft warning network; in observing the use of horse cavalry in coöperation with and in action against mechanized forces; and in studying the problems connected with the use of large motorized masses and tank masses. The military forces in the maneuvers comprised the Third Army, commanded by Lieutenant General Stanley D. Embick, who was the Director of the exercises. Units of the Third Army came from their stations in 33 states to participate.

Two army Corps make up the Third Army: the Ninth and the Fourth Army Corps. Each of these held its own corps maneuver prior to meeting in mock warfare in the Sabine and Red River valleys.

Prior to their concentration, these units underwent intensive training during last winter and early Spring. Units of the Ninth Corps then concentrated in the area between the Neches River and the Sabine River, the latter being the boundary between Texas and Louisiana. This Corps, known as the "Red" army for the main maneuver, consisted of 30,000 men under command of Major General Walter Krueger, with temporary headquarters at Nacogdoches, Texas. The Ninth Corps maneuver was carried on from April 27 to May 7. The Fourth Corps, of 40,000 men, was known as the "Blue" army in the war game, and is commanded by Major General Walter C. Short. Concentration of this Corps was at Fort Benning, Georgia. It held a corps maneuver prior to May 5, when it began an overland trek to Camp Beauregard, near Alexandria, Louisiana.

Neither Corps maneuver of these two "enemy" forces involved noteworthy demand upon the telephone system other than increased volumes of local and long distance telephone calls and a demand for more facilities at such points as Ft. Benning and Nacogdoches, all of which were handled in routine fashion.

A new and more interesting phase of the war games, to both Army and telephone men, began May 5, when the Blue army, hearing that the Reds were becoming bellicose, began a 600-mile march to Camp Beauregard.

This movement was made in motorized columns of roughly 10,000 men, moving forward half of each day before camping. Two routes were employed, to reduce interference with regular highway traffic, the northern one passing through Jackson, Miss., and the southern through New Orleans. Temporary telephone service was usually furnished at each camp if sufficient telephones were not already available.

During this march, Red army aircraft attempted to destroy the Blue army columns by direct attack, and harassed it by bombing bridges and other strategic points. To notify Blue aviation forces of their forays, the "Aircraft Warning Service" was established and operated May 7 through May 11.

The Civilian Aircraft Warning Service

The extent of the Third Army Aircraft Warning Service was the greatest of any such system yet organized. It covered 234 counties, including 17 in southern Arkansas, 11 in Western Florida, and all of the 57 counties (parishes) in Louisiana, the 82 in Mississippi and the 67 in Alabama.

This area was divided into 16-mile squares, an arbitrary military grid, totalling 1600 squares. In each of these squares a subdivision was made

CONTROL SECTION AT CAMP BEAUREGARD, LA.

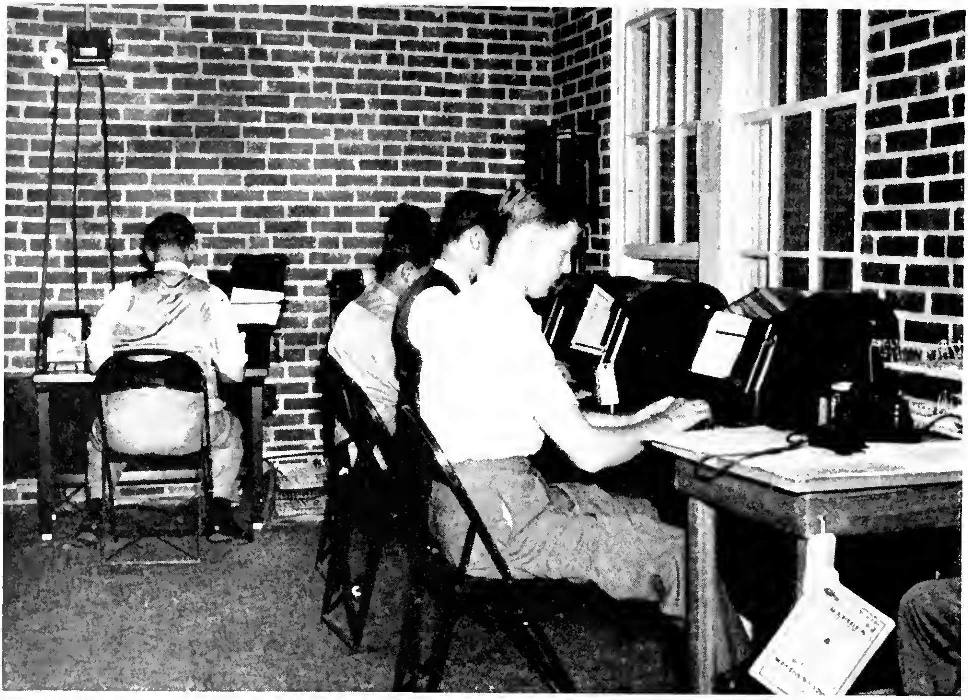
Note the "hang-up" hand telephones, with visual signals instead of bells

into 8-mile quadrangles, with a civilian observation post located as near the center of the quadrangle as possible. With alternates, some ten thousand volunteer civilian observers were engaged in watching for airplanes.

Securing these civilian observers was a task which the American Legion handled in excellent style. Through the Department Commanders and the District Commanders, county chiefs were selected, and they in turn chose the observers. Many of the observers, incidentally, were women.

American Legion representatives, usually the county chiefs, had the full coöperation of the telephone company managers in selecting telephones at existing locations for use as observation posts. This coöperation included the Southwestern Bell Telephone Company representatives in Arkansas, the Southern Bell people in the remaining states, and the many independent telephone company representatives throughout the entire Warning Area.

One of the benefits of the warning network was the experience given civilians in watching for and reporting plane flights, while their enthusiasm in devoting their time to this activity brought satisfaction to army



TYPING THE ARMY'S MESSAGES BY WIRE

Teletypewriters and circuits were furnished by the Southern Bell Telephone and Telegraph Company; the operators shown here were provided by the Western Union Telegraph Co.

executive officers. The United States Coast Guard assisted in the network by operating inshore patrol vessels, and by operating observer posts at or near their Shore Stations. At some more inaccessible points, federal and state forestry employes acted as observers.

Identification of observation posts was effected by giving each post a combination of a number and a name. The names ran vertically, for each 16-mile layer on the master map of the Warning Area, while the numbers ran across. The point of origin was the southwest, or lower left, corner of the map. A section of the Master Map was furnished each observation post, showing its identification. A Master Map, showing the available telephone central offices, was prepared by Southern Bell and supplied to each District Chief of the observer network. Observers were then instructed as to the method of reporting airplane flights, and furnished blank forms for recording their observations.

An observer, on seeing two or more airplanes, called for the long distance operator, said *"flash,"* and gave the number of the calling telephone. The operator then connected the observer with the Information Center at Maxwell Field in Montgomery, Alabama, where the information from the entire Warning Area was received. All long distance *"flash"* messages were handled on a station-to-station basis, and, by pre-arrangement with the Army, automatically accepted by operators as "collect" calls.

The traffic department of Southern Bell was in charge of instructing operators in handling these flash messages. This was covered in brief instruction memoranda to "A" operators, farmers' exchanges, tributary offices, originating toll centers, intermediate toll centers, and the inward toll operators in Montgomery.

Maxwell Field in Montgomery was supplied with ten toll terminals, equipped with visual signals instead of bells. The lights remained on until the army operator answered. Operators were enlisted men from the 51st Signal Battalion, Fort Monmouth, New Jersey.

A preliminary test of the warning network was made May 2. Part of the observers were given test messages, and these were put through and then checked for accuracy by comparing the Maxwell Field operator's recording of each call with the original. This developed the fact that the New Jersey men did not always understand the soft Cajun dialect of the bayous, or the equally soft accents of the cotton belt natives. Experience, however, eliminated this difficulty.

THE reports of aircraft in formation received at the Information Center at Maxwell Field from observers were evaluated by Army experts, who then

TELETYPEWRITER ON WHEELS

A Signal Corps sergeant operating a Bell System teletypewriter in an Army truck at the air field base of the Red army at Lufkin, Tex. The instrument is shown as it receives a message from the Red army general headquarters at Jasper, Tex.

notified friendly air bases by telephone, teletypewriter, or on the Army radio, so that proper defensive steps could be taken.

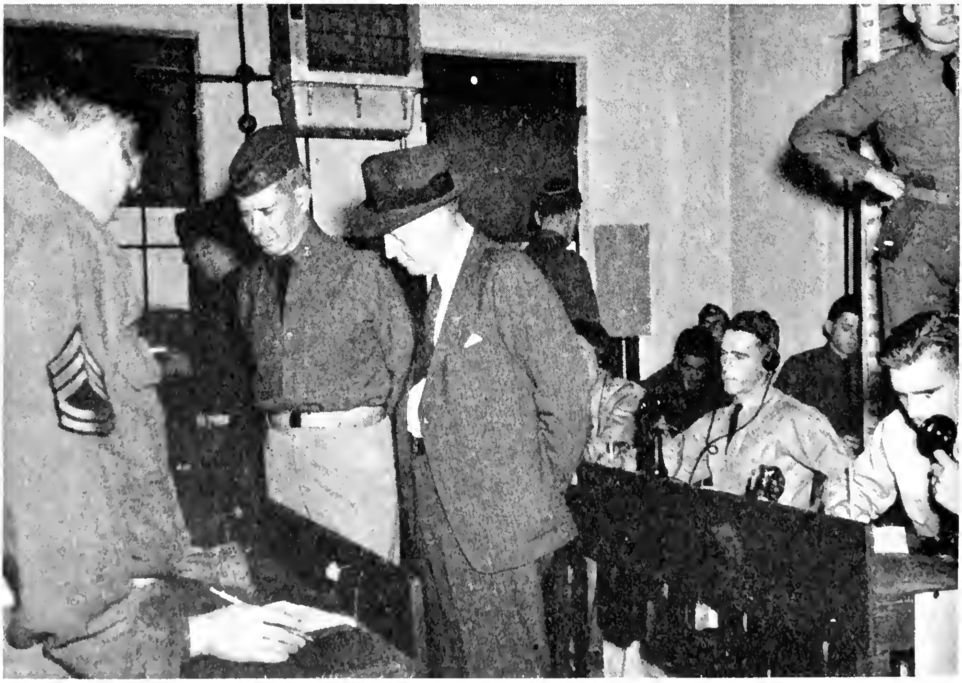
Operation of the Aircraft Warning Service was on Central Standard Time, and covered the following periods, beginning Tuesday, May 7:

May 7—8:30 A.M. to 2:30 P.M.
May 8—8:30 A.M. to 2:30 P.M.
May 9—7:00 A.M. to 10:00 A.M., and 3:00 P.M. to 6:00 P.M.
May 10—7:00 A.M. to 10:00 A.M., and 2:00 P.M. to 5:00 P.M.
May 11—5:00 A.M. to 8:00 A.M., and 1:00 P.M. to 4:00 P.M.

Operation of the Aircraft Warning Service caused no delays in the handling of the Company's normal long distance service, since the number of "flash" calls was relatively small, as shown by the following figures:

State	Messages	Av. Length of Conversation	Speed of Service
Alabama	393	91 Sec.	42 Sec.
Arkansas	26	114 Sec.	56 Sec.
Florida	87	122 Sec.	62 Sec.
Louisiana	512	80 Sec.	57 Sec.
Mississippi	451	81 Sec.	33 Sec.

This was a total of 1,469 calls for the five days, or about ten an hour per state for a six-hour period. The average length of these conversations was 86 seconds, and the average speed



RECEIVING THE "FLASH" MESSAGES

Army operators are recording reports of airplanes seen by civilians who formed the "Aircraft Warning Service." Col. Robert W. Collins, C.A.C. (left), in command of this volunteer service, and Mr. E. T. Harris, District Manager for the Southern Bell Company at Montgomery, are observing operations

PLOTTING THE REPORTS

Reports from civilian observers, plotted as they come in, indicate the direction of both invading and defending planes

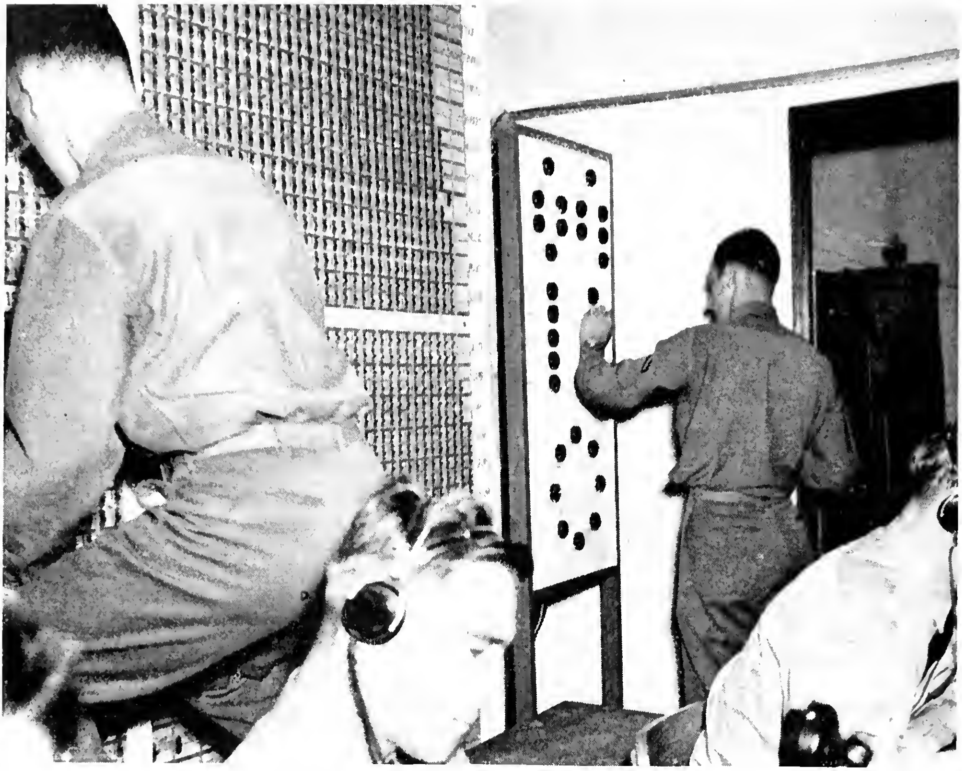
of establishing connections by long distance operators was 46 seconds.

Opinions of observers and Army officers were favorable regarding the operation of the telephone network. Here, for example, is a letter from the County Chief at Brookhaven, Miss.:

> "As County Chief of the air warning service for Lincoln County, I want to thank you and your excellent force for the splendid coöperation and efficient service rendered us during the period May 7 to 11. All of our posts report that your operators were very diligent and courteous in the handling of all *flash* messages they had during this maneuver."

One of the Army bulletins stated:

> "The Southern Bell Telephone Company accepted the responsibility of coordinating the activities of its affiliated companies and all independent companies located within the Warning Service Area. The officials of the Southern Bell Telephone Company have worked untiringly in their efforts to provide the best communication system obtainable. Their coöperation has been outstanding.
>
> "The managers of the local telephone exchanges throughout the entire area have contributed their time and technical knowledge toward assisting County Chiefs, observers and the Army in selecting telephones which would be most suitable for the service. All have generously devoted their energies toward providing the best communication system possible. The coöperative interest which has been displayed by all telephone officials has contributed to a



CONTROLLING THE MAP LIGHTS

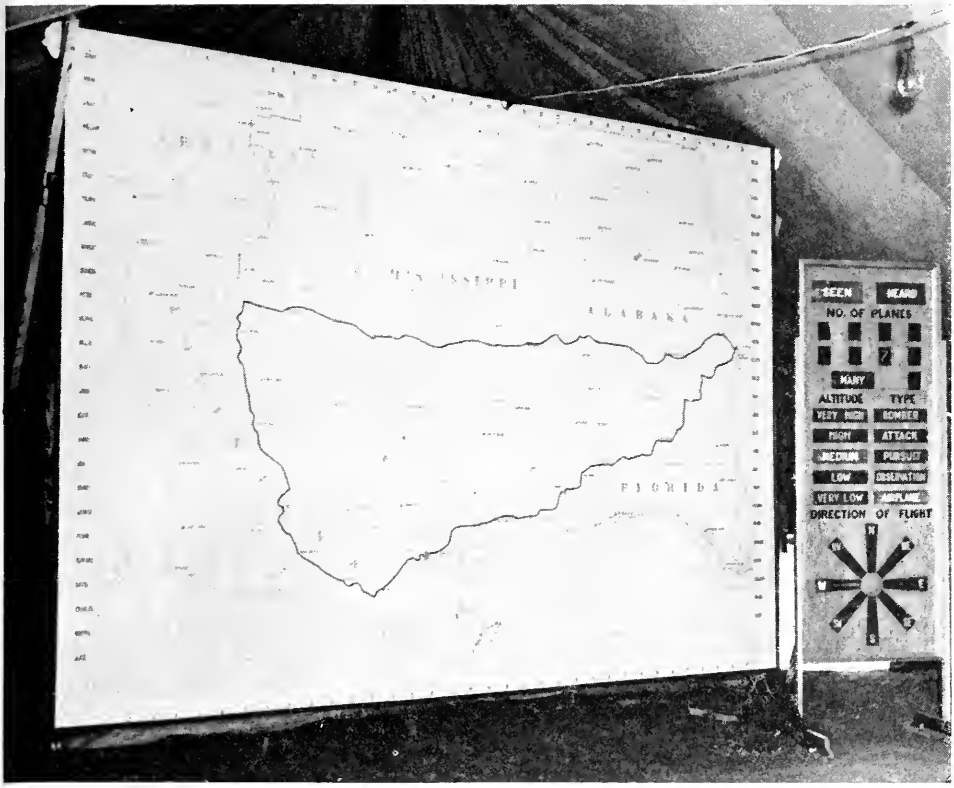
These switchboards control electric lights on the large maps and descriptive panels in the visitors' assembly tent—shown on the opposite page—and the flight evaluation room

great extent to the development of the organization as it stands today."

Use of Toll Credit Cards

SUCCESSFUL use of regular Bell System "Toll Credit Cards" was an innovation with the Third Army Maneuvers. During such an extensive series of military operations, Army officers necessarily have to make use of commercial long distance telephone facilities from various points. Army Regulations make no provision for reimbursement for such expenditures, and "collect" calls are not always practicable.

Southern Bell therefore suggested the use of the credit cards, and the suggestion was adopted. About 400 such cards were issued in blank to the Corps Area Signal Officer at Ft. McPherson, Ga., who reissued the cards to individual officers who were to act as umpires, control officers, or on tactical and administrative units. As the cards were issued, the Signal Officer furnished the telephone company with the information regarding each card, for use of the various departments. All Bell and independent company traffic forces in the Maneuver territory were instructed on the



THEATER OF OPERATIONS

On this map of the maneuver territory, each of the small blocks, 16 miles square, contains four posts of the "Aircraft Warning Service," each represented by a light. Successive reports result in a row of lights which shows graphically the line of flight of planes. The heavy irregular black lines trace the separate routes followed by the Blue forces from Fort Benning, Ga., to Camp Beauregard, La.

handling of calls made with the credit cards. The cards were returned to the Signal Officer at the conclusion of the Maneuvers, for cancellation. While considerable use of the cards was made during the Corps maneuvers at Ft. Benning, and on the march to Louisiana, most of the use came during the "battle" of the Sabine Valley.

Cards for the Red army were issued by the Southwestern Bell Telephone Company, handled through the Signal Officer of the Ninth Army at San Antonio, Texas.

Blue army officers placed 4,719 long distance telephone calls with their credit cards during the Maneuvers.

In addition to local and long distance telephonic communication, the Maneuvers were served by private lines and other special services. The local circuits from Alexandria to Camp Beauregard were increased, while ten trunks were added from Columbus, Ga., out to Ft. Benning. At Montgomery, five extra trunks were supplied during the Aircraft Warning Service operations.

Practically all of the special services furnished by Southern Bell were located in Louisiana. Four teletypewriter channels with ※15 machines, and four such channels without machines, were provided. Army switchboards were connected with full-period talking circuits between Leesville and Florien, Many and Florien, and from Leesville to DeRidder. Full-period talking circuits were furnished from Camp Beauregard to Dry Prong, Leesville and Barksdale Field at Shreveport, the latter having a drop at the Natchitoches airport.

Teletypewriter service, using ※15 machines, was provided by the American Telephone and Telegraph Company between Maxwell Field at Montgomery, Ala., and the airport at McComb, Miss., on a full period basis, May 1.

The Red Army Maneuvers

As the maneuvers of the Ninth Corps Red army took place chiefly in East Texas in an area served by the Southwestern Bell Telephone Company, its commercial communication requirements were furnished by that company.

The main line circuit layout, forming the Red communication network, was a circular arrangement of talking and teletypewriter circuits extending to army depots, supply bases, etc., in Nacogdoches, Lufkin, Beaumont, Jasper, and San Augustine, Texas. These permanent establishments were connected to moving field headquarters by army extension lines which could be "tapped" to the permanent circuits at several points. All told, eight full talking circuits, totalling 829 miles, were used by the Ninth Corps Red army and leased jointly from the Southern Bell Company and the Southwestern Bell.

The Army also leased, through Southwestern Bell, 582 airline miles of teletypewriter circuits in Texas and Louisiana. Neither of the above includes services for the Fourth Army Corps or the Third Army handled by the Southern Bell Company, except commonly used umpire and referee channels.

Close coördination was maintained with Signal Corps officers throughout the maneuvers, and the experience gained during these military exercises was valuable in demonstrating the ability of Bell System equipment and services to meet the demands made upon them under field conditions.

Equipment and services furnished by the Southwestern Bell Company included 20 business telephones, five service line business telephones, and two PBX trunks at Beaumont, Jasper, Nacogdoches, and San Augustine, Tex.; 35 private telephone lines at Jasper, Kirbyville, and San Augustine, Tex.; 21 ※19 and five ※15 teletypewriter installations in Texas and four teletypewriter channels in Louisiana; three foreign exchange lines and one private line in Texas and two private lines in Louisiana.

Two emergency portable radio telephone sets were also held available, and were used experimentally.

In addition, Southwestern Bell placed 20 circuit miles of wire between Jasper and a point near Horton, Texas, on an existing toll pole line. Army wire and telephone company labor were used.

On another work order, the telephone company placed, on a contract basis, 1509 poles to connect Army telephone and teletypewriter facilities between Jasper, Texas, and Leesville, Louisiana; also from San Augustine, Texas, to the Sabine River. Wire on these leads was strung by Army personnel.

In a radio broadcast on May 4, Major W. O. Reeder, Signal Officer of the Ninth Army Corps, reviewed the communications needs of the Army and the work of the Signal Corps. His broadcast was carried over Radio Stations WFAA, Dallas; KPRC, Houston; and WOAI, San Antonio. Major Reeder concluded his talk with the following statement:

> "It would be sheer ingratitude to close this brief talk without paying a sincere tribute to the patriotic coöperation of the Southwestern Bell Telephone Company, whose officers have assisted so ably in the planning of the Ninth Corps' communication system and whose employees are bending every effort to see that their part of the maneuver communications system does not fail."

THE conclusion of the Maneuvers came May 25, after which the units of the Ninth and Fourth Army Corps went back to their respective posts for further training during the summer. The setting for their "battle" at Camp Beauregard, according to present plans, will be the scene of another giant maneuver of National Guard troops during the summer, so part of the communication facilities may be left in place.

Various critiques of the maneuvers discussed the relative value of radio and telephone land line communications. Radio, obviously, must be used for reaching airplanes, and often is useful in making contact with mobile units. However, the lessons of Europe's war seem to indicate that wire communications are the mainstay.

Regardless of these considerations, Army officers generally were generous in their commendation of the telephone service, and of the folks who furnished it to them, during the "Battle of the Bayous" in the Sabine valley.

* * *

The author wishes to acknowledge the assistance of Mr. Frank Witten, advertising manager for Texas of the Southwestern Bell Telephone Company, in the preparation of the material covering activities in that company's territory.

CONVENTIONS AND COMMUNICATIONS

These Quadrennial Political Events Create a Week's Peak Demand for a Variety of Bell System Services Which Is Met Successfully through Planning, Co-ordination—and Quick Work

By PETER L. SCHAUBLE

Due to the exigencies of publication schedule, the following account can deal only with the national convention held in Philadelphia in June; but it may be taken as generally descriptive also of the equipment and services provided at the convention in Chicago, which took place after this issue of the QUARTERLY *had gone to press.*

DURING the Republican national convention of 1896—according to a newspaper dispatch of the time—William McKinley, at his home in Canton, O., was in touch by telephone with the convention hall in St. Louis, Mo. Sixteen years earlier, and therefore only four years after the invention of the telephone, there had been—also according to a contemporary newspaper item—a local call to a member of a convention committee a few days before the convention of 1880 in Chicago. Thus for at least sixty years the telephone has played a part in the political life, as in every other aspect of life, of the American people.

Particularly during the last two decades has the development of electrical communication brought to citizens from coast to coast increasingly full and speedy accounts of the proceedings by which the two major parties select their candidates for the highest elective office in the land. The provisions which the Bell System has made to facilitate the business, and to aid in the dissemination of news of every act, of these quadrennial dramas have twice before been described in these pages.*

This convention year the telephone, telegraph, radio, teletypewriter, telephotography, the press and—for the first time—television combined to keep Mr. and Mrs. America, back home, virtually as well informed about what was taking place at the convention as their duly elected delegates who were actually participating in the ever-changing scene. In the parlance of the news room, it was "coverage" to a degree never before attained. Inextricably woven into this gigantic network of electrical communication were the many serv-

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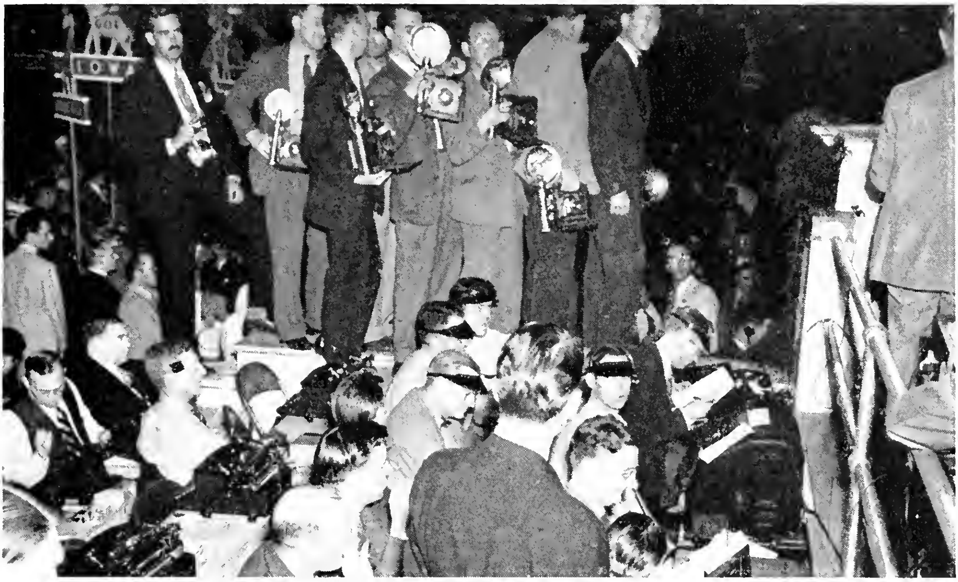
* "Communications and the National Conventions," by G. K. McCorkle, QUARTERLY, July, 1932; "All America at the Conventions," by G. G. Breed, QUARTERLY, July, 1936.



NEWS IN THE MAKING

A corner of the press stand during the convention

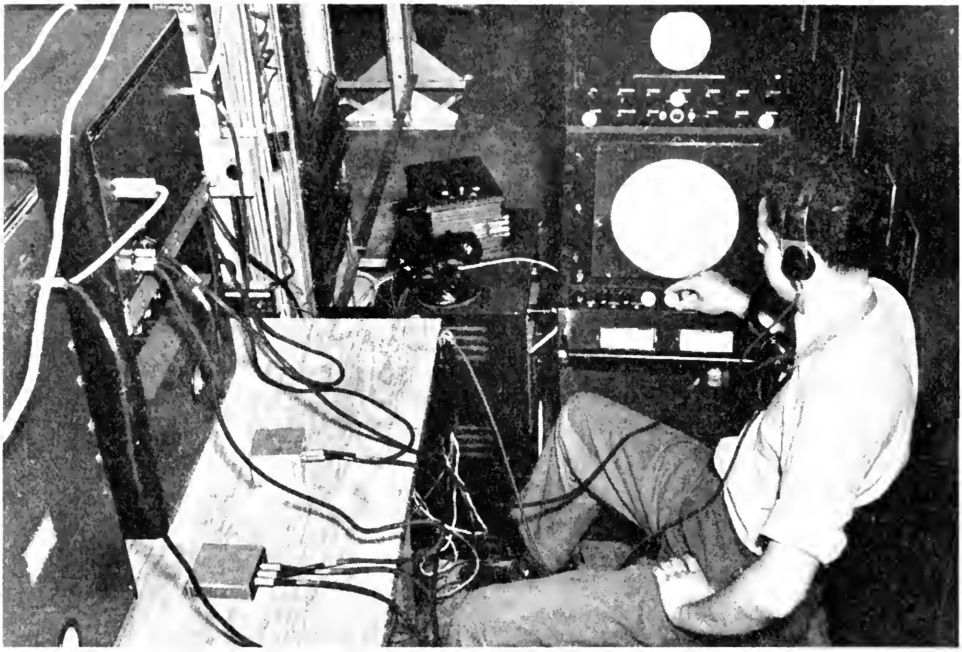
ices which the Bell System has developed, and furnishes to meet the widely varying needs of its customers.

Responsibilities of the Job

It is a fundamental aim of the Bell System to provide a service so complete that practically any one, anywhere, can talk by telephone with any one else, anywhere in the country. At times during the progress of a national political convention, it would seem to a casual observer that everybody in the convention city was trying to accomplish that very thing.

The job of providing service for a convention is no overnight, ordinary run of the mill assignment for the local telephone company and the Long Lines Department of the A. T. & T. Co. It is doubtful if any other recurring event of national importance closely approximates the communication requirements of such an assembly, whose deliberations at a critical moment may swiftly change as the result of a telephone call across the street or to a far-away state.

It is on such occasions that communication agencies readily assume increased responsibilities, and the task of providing high-grade, dependable facilities takes on added significance. There must be no unforeseen obstacles to delay or interrupt the swift dissemination of information to the waiting public, whether it be in the form of pictures transmitted by wire, messages over telephone lines, or a radio broadcast. It is under such circumstances that complete coördination of effort, as exemplified by the nation-wide organization of the Bell System, becomes increasingly important.



TELEVISION MONITOR

An engineer of the Bell Telephone Laboratories guards the television program as the signals leave Convention Hall for transmission over telephone wires to the coaxial cable in downtown Philadelphia

Each succeeding convention has its own peculiarities and new problems. No two are precisely alike. And, in passing, it is not unimportant to note that the conventions of 1940 surpassed all others in demands upon the communications industry.

Improvements in the telephone art, supplemented by a highly skillful and trained organization, made it possible to meet these unprecedented demands with promptness and dispatch. As one man, the telephone forces tackled the job and saw it through to the finish.

Careful planning is the first essential element in providing the necessary telephone service for a political convention. Weeks before the opening session, telephone groups began to lay their plans. Slowly the job gathered momentum, and reached a peak of activity when the delegations and thousands of guests from the states rolled into the host city by rail, plane, and motor, and swarmed into hotels assigned to them by convention officials.

The convention, to all intent and purpose, was then on; and no respite from the sustained stress was in prospect for telephone men and women until a week later, when the city once again resumed the even tenor of its ways.

LET us take a look as what is going on in Philadelphia's Convention Hall.

TELEVISION PREVIEW
Miss Mary E. Martin, assistant chairman of the convention, is interviewed before the television camera on the sidewalk in front of convention hall prior to the opening of the convention. At the right is the image as seen by "televiewers" after transmittal to NBC's New York studio

The Chairman steps to the rostrum, calls the convention to order. His every word is picked up by microphones of the broadcasting companies and flashed to millions listening at their receiving sets.

Operating from specially devised booths far above the floor of the convention, the broadcasting companies' ingeniously devised and strategically located facilities permit, by the mere turning of control switches, the picking up of speeches by delegates, state by state announcement of the balloting, interspersed at intervals by interviews with candidates at their hotels in downtown Philadelphia and by the colorful comments of radio commentators.

Flanking the platform on either side are row after row of newspaper men and women, their pencils and typewriters putting on paper pulsing word descriptions of the proceedings which are transmitted instantly by scores of nearby teletypewriter and Morse key operators to the newspapers throughout the land. In a few brief minutes people on the streets of New York, Chicago, San Francisco and many other cities will read these detailed accounts of events unfolding

A Bell System Plant man (right) checking up on a teletypewriter. Machines such as these are used by the great press associations

at the Convention, so swift are the agencies of communication.

The Newcomer: Television

AH, here is something to arrest your attention! As you look about the great hall, your eye catches a glimpse of two odd-looking contrivances on an improvised platform extending from the first balcony. "Television cameras," some one informs you. Then a National Broadcasting Company engineer explains that NBC, with the coöperation of the Bell Telephone Laboratories, is televising the convention.

Four television cameras are employed at Philadelphia: two are set up to catch the kaleidoscopic scenes in Convention Hall, a third is located in a special studio for interview purposes, and the fourth is utilized to televise party chieftains and others as they arrive at the Hall.

At certain hours during the day and evening the programs are transmitted over telephone wires from Convention Hall to the long distance telephone building in downtown Philadelphia, and thence over the experimental coaxial cable to New York, where they are "telecast" by Station W2XBS in Manhattan. It is the first time the coaxial cable has been used to transmit television signals to be broadcast to the public.

This cable, manufactured by Western Electric Company, has been equipped by the Bell Telephone Laboratories for transmitting television signals, including those used at present by the National Broadcasting Company. This has required the provision of amplifiers at 5-mile intervals that will transmit frequencies up to about three million cycles, and equalizers that will maintain proper strength of all the frequencies within this very wide band as well as equal times of arrival within a small fraction of a millionth of a second.

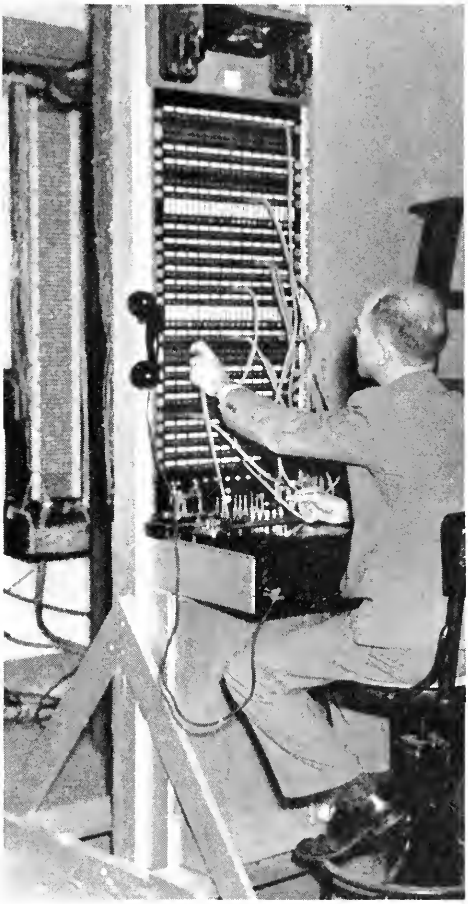
Besides equipping the coaxial cable, it has been necessary to arrange for transmission between Convention Hall and the long distance telephone building in Philadelphia, and between the Laboratories and Radio City in New York. For these shorter distances, it is possible to use regular cable pairs, as was done for recent television transmission from Madison Square Garden and Radio City. Such circuits do not transmit television signals as readily as does the coaxial cable, and amplifiers are needed at approximately one-mile intervals.

These amplifiers are provided with suitable "equalizers" and are located and installed with special precautions to avoid "noise" disturbances. In New York City a new type of cable, employing shielded pairs of wires, has also been installed to link the Bell Laboratories with Radio City. This new cable has the advantage of requiring no intermediate amplifiers for the distance involved.

For the cable runs at each end of the coaxial cable, it is simplest to transmit the signals just as received from the television camera, the so-called video signals, extending from a few cycles per second up to several million. For most satisfactory transmission over the long length of coaxial cable, however, special equipment is provided at Philadelphia to shift the frequency band upward by about 300,000 cycles. Corresponding equipment is provided at the Laboratories to bring the signals back to the video range.

The quality of the results obtained was so satisfactory—to lapse for a moment into the past tense—that the experiment proved eminently worth while from the standpoint not only of the Bell Telephone Laboratories and the NBC but from that of the public as well. It is estimated that as many as 50,000 persons in and around New York at times looked in on the convention via this modern miracle of television.

Proceeding around mammoth Convention Hall, in one of the corridors you come across a specially-installed battery of telephones with pages standing nearby. These telephones are connected to the headquarters of the various candidates in downtown hotels and enable them to communicate promptly with delegates while the convention is in session.



The Long Lines Department of the A. T. & T. Co. installed this testboard in Convention Hall for the duration of the convention

At various locations are twelve telephones connected to the private branch exchange serving the National Committee in the Bellevue-Stratford Hotel. Two others, connected to the same switchboard, are on the speakers' platform.

The great hall is adequately equipped with telephones for the convenience of the crowds. Supplementing the some half-hundred telephone booths permanently located on the premises is an attended pay-station room with twelve booths, one of which contains a telephone for the use of persons with impaired hearing.

Outside the main entrance to the structure stands an attended pay-station trailer with four booths. Curious throngs inspect this mobile telephone unit; hundreds of others step inside, give their desired numbers to the operator, and from the comfort of air-conditioned booths make important last-minute calls before the convention session gets under way.

Squads of telephone men hurry about the building, installing additional facilities and making necessary changes in the existing wire network to meet the inevitable last-minute requests. Their headquarters are in a temporary Plant office on the first floor. Essential materials are on hand; there is no delay in completing an order. In another room is a temporary Business Office for receiving these urgent requests for service.

Providing Adequate Facilities

IMPORTANT to the telephone company is the objective that adequate facilities shall be available at all times, wherever and whenever they may be needed by the thousands of delegates and visitors to the convention city. As an added safeguard at Convention Hall, telephone wires entered the building by two different routes, as did they also at the Bellevue-Stratford Hotel.

To insure the public having the best service possible, there was made a thorough inspection of all public telephone facilities and private branch exchanges in the various hotels. All possible changes and additions were completed well ahead of convention week, including the installation of private branch exchanges to serve the candidates, and a three-position board for the use of the National Committee.

However, the entire telephone job cannot be handled in advance. Once the convention opens, there is a continuous flow of requests from all quarters, at all hours. An additional line is wanted here; broadcasting circuits to two hotels are set up late at night so that the successful candidate, hurrying back and forth between them, may speak to the nation; private branch exchange batteries are watched closely, for the power requirements are heavy; emergency charging sets are provided and held in readiness. There is no let-up in the activity.

From a telephone standpoint, one of the busiest spots in Philadelphia was the private branch exchange in the Bellevue-Stratford Hotel—an eight position board which serves 1,000 hotel telephones. To care for the situation here, the operating force was built up to a peak of thirty-one women. Working in tours, they handled traffic loads ranging up to 1200 per cent above normal. Comparable situations existed in the Benjamin Franklin and other big hotels.

Local and long distance telephone traffic ebbed and flowed. During convention week in Philadelphia, long distance calls ran about thirteen per cent above normal. On Friday—the day the convention wound up its balloting with the selection of a Vice

PLANT HEADQUARTERS IN CONVENTION HALL

The Bell Telephone Company of Pennsylvania provided men and materials to meet quickly the day-to-day needs of the convention

Presidential nominee—they shot up twenty per cent above normal.

Of material assistance in the expeditious handling of the great volume of calls to and from the delegates and convention officials was a one-page telephone "directory" which listed the many individuals, committees, news associations and other agencies which had subscribed for service during the convention. This information sheet was revised and issued daily to private branch exchanges in hotels, and to newspapers, telegraph companies, and the like. It also was used by the telephone company's own information operators.

IMPOSSIBLE is it to recount here all that was done in a telephone way to let America listen and look in on the dramatic proceedings of a great political convention. It is enough to say that the countless telephone men and women working quietly, efficiently, intently behind the scenes—whether in the midst of the frenzied activity in the convention city or performing a routine test at some remote outpost of the Bell System network—gave generously of their painstaking best and proudly played their part in another historic high-light in the life of the nation they serve.

SUN SPOTS AND TELEPHONE SERVICE

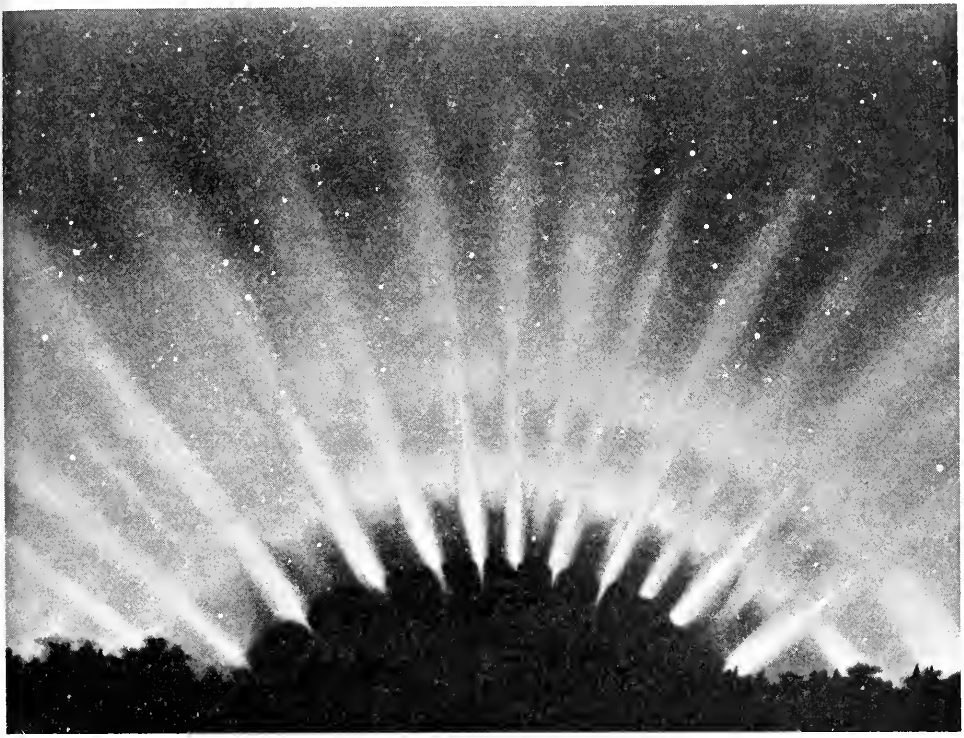
Solar Disturbances Which Influence both the Kennelly-Heaviside Layer and Earth Currents Probably Cause Magnetic Storms Like That Which Affected Electrical Communications Last March

By GLEN IRELAND

In the remote past, our ancestors were undoubtedly disturbed by unusual displays of northern lights, which we now refer to as aurora borealis or polar lights. However, amidst the crude surroundings of centuries ago the presence of these lights probably had no other effect than to awe, or to be considered, along with other celestial phenomena, as portending great events. Later, after the compass came into general use (about the 13th century), mariners may have noticed on occasion some erratic movement of the compass needle, and it is possible that the more scientific minded of the early mariners may have noted a correlation between these movements and the unusual displays of polar lights.

In 1844 the first commercial electromagnetic telegraph system was placed in operation, between Baltimore and Washington, and during the next few years this form of communication spread rapidly both in the United States and in other parts of the world. Soon after these systems, which operated with a single wire and ground return, were placed in operation, there occasionally appeared other signals or interference which sometimes became so frequent and intense as to interfere seriously with transmission of telegrams. It is recorded that a British scientist, W. H. Barlow, after close observation of this interference to the telegraph, concluded in 1847 that the interference came from the earth. Soon thereafter it was recognized that these occasions of severe interference to the telegraph, called earth current storms, were associated with brilliant northern lights in the same manner as was the erratic behavior of compass needles. In 1859 all the grounded telegraph lines in the world were apparently affected by a very severe storm. During most of the seven-day period from August 29 to September 4 of that year, it was impossible to transmit telegrams. On one line in France which spanned a distance of 373 miles the current was said to be "equal to that produced by a battery of 800 volts."

The effects of such storms have gradually become of much greater importance as first the telegraph, then the telephone, and lastly radio have been introduced and become more



HAYDEN PLANETARIUM

A RARE DISPLAY OF THE AURORA BOREALIS

Showing both arches and streamers, this picture is reproduced from a pastel made more than half a century ago by Etienne Trouvelot (1827–1895), artist and amateur astronomer

widespread. Due to the presence of these and many other new services, and the dependence which our modern civilization places on them, the great magnetic storm which occurred on Sunday, March 24, 1940, probably had more diverse reactions on communication services than any that have occurred before. It is believed that readers of the QUARTERLY will be interested in a discussion of the causes of such storms and some information about the March 24 storm, particularly as it affected Bell System services.

The underlying cause of the magnetic and electrical disturbances on the earth probably resides in disturbances in solar activity, of which sun spots are perhaps only one manifestation. This has become evident as a result of a great amount of data taken over a long period of years. These data show a correlation between solar activity, as revealed by the sun spots, and the occurrence and intensity of polar lights and electrical and magnetic disturbances on earth. In this connection, Figure 1 shows the annual mean of relative sun spot numbers and the annual mean magnetic activity from 1835 to 1939.* The

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* The magnetic activity is measured by an index that depends on the day-to-day change of the mean horizontal intensity of the earth's magnetic field.

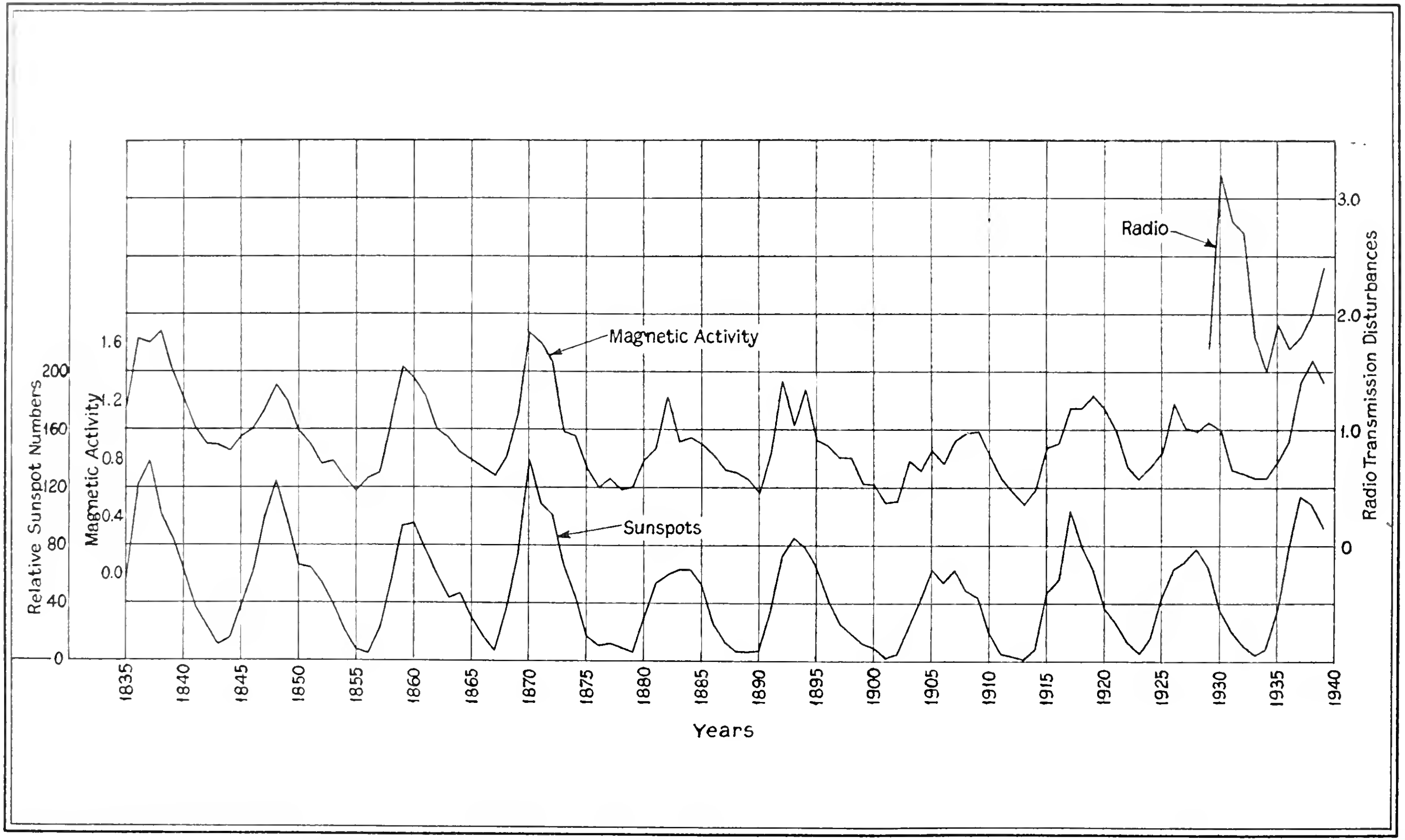
Radio
Magnetic Activity
Sunspots
Relative Sunspot Numbers
0
40
80
120
160
200
Magnetic Activity
0.0
0.4
0.8
1.2
1.6
Radio Transmission Disturbances
0
1.0
2.0
3.0
1835
1840
1845
1850
1855
1860
1865
1870
1875
1880
1885
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
Years

FIG. 1

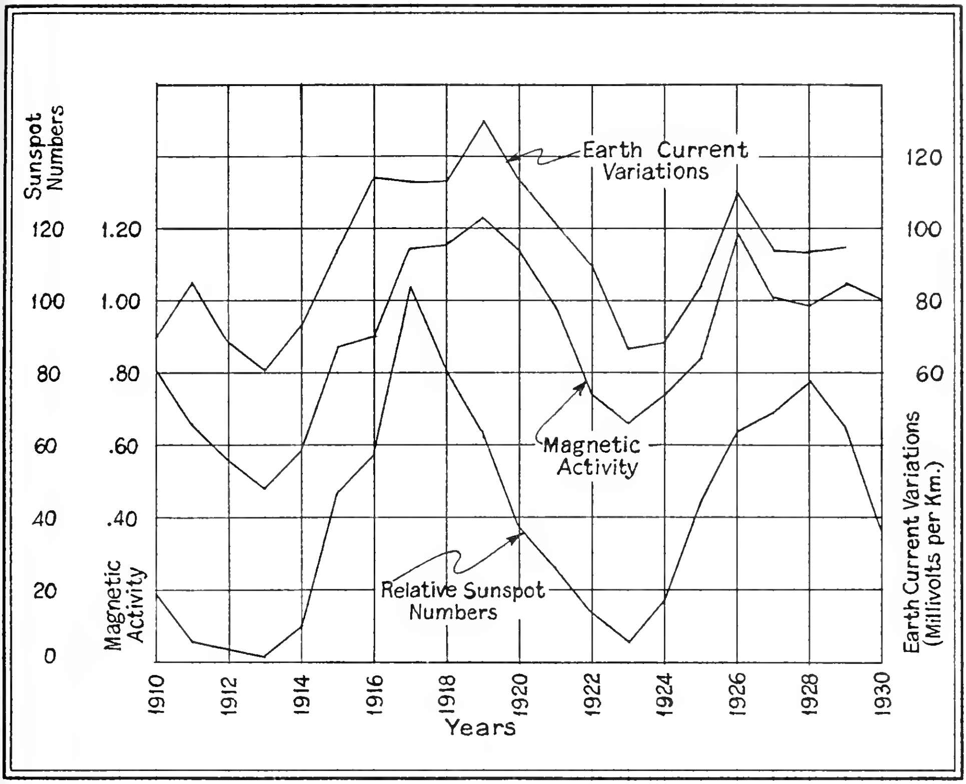

FIG. 2

Chart showing the annual mean of relative sun spot numbers, of magnetic activity, and of earth current variations *

relative transmission disturbance over short wave radio channels for the period from 1929 to 1939, inclusive, is likewise shown. The correspondence between the magnetic activity and relative radio disturbances, on the one hand, and the relative sun spot numbers, on the other, is very evident. All show marked maxima at intervals of about 11 years. The question as to why, in the first place, the solar activity should vary in these 11-year cycles is still unanswered. Incidentally, it is interesting to note from Figure 1 that there was a definite peak in magnetic activity in 1859, the year when the severe effects on telegraph circuits previously mentioned were experienced. Figure 2 illustrates the same general relationship between the annual mean sun spot numbers and annual mean magnetic activity, and, in addition, indicates further their relationship to earth current variations. Further evidence of the correlation between solar activity and the presence of polar lights and magnetic and electrical disturbances

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* Earth current variations from "The Natural Electric Currents in the Earth's Crust," by O. H. Gish, in *The Scientific Monthly*, January, 1931.

is indicated by the fact that after the initial occurrence of these phenomena, there is a considerable tendency for the polar lights and the disturbances to recur about 27 days later. This is the time required for the sun, at the latitude where sun spots are most prevalent, to make one complete rotation as viewed from the earth. Short wave radio transmission measurements further bear out this 27-day relationship.

IN view of the above information, and of additional data not cited here, there is general agreement that the magnetic and electrical disturbances in the earth's surface and atmosphere are basically due to tremendous disturbances on the sun, which are usually accompanied by sun spots. However, just how these disturbances on the sun create in turn the disturbances on the earth is not a matter of complete agreement among astronomers, physicists, and others interested in the study of solar activity and its effects.

There is considerable evidence to show that the disturbed areas on the sun emit streams of electrically charged corpuscles. A stream of electrically charged corpuscles, on encountering the ionized layer which exists above the surface of the earth (known as the Kennelly-Heaviside layer), greatly affects the state of ionization in this layer, causing a violent boiling or turbulence of the entire ionosphere in the auroral zone. Then, either directly by flow toward the region of the earth's magnetic poles, or indirectly from reactions set up in the ionized layer, large currents are caused to flow in the earth. The theory that the sun's emission is of the nature of electrically charged corpuscles which reach the earth's atmosphere and the earth itself, is supported by photographs of auroral displays in northern latitudes and analyses of their spectrum, as discussed in a previous issue of the QUARTERLY.*

Since the amount of current flowing in earth varies greatly from point to point because of geological differences in the make-up of the earth and variations in resistivity along the earth's surface, the voltages which are present likewise vary, being considerably greater per unit length between some points of the earth's surface than between others. Also, the ground currents and voltages generally tend to become greater in upper latitudes and smaller toward the equator. This may be explained in terms of the theory mentioned previously that the charged corpuscles would tend to flow toward the regions of the earth's magnetic poles and that, accordingly, the current flow would be of greatest density in those regions.

CONSIDERING now the effect on communication circuits, it is evident that short wave radio circuits, which depend for successful transmission on a certain state of ionization of the Kennelly-Heaviside layer, would be greatly affected during periods of solar activity. (Waves from a short wave radio transmitter are propagated into space and, on encountering the Kennelly-Heaviside layer, are reflected back to the earth, to be intercepted by the receiver at the distant

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* "The Aurora Borealis," by R. W. King, QUARTERLY, April, 1926.

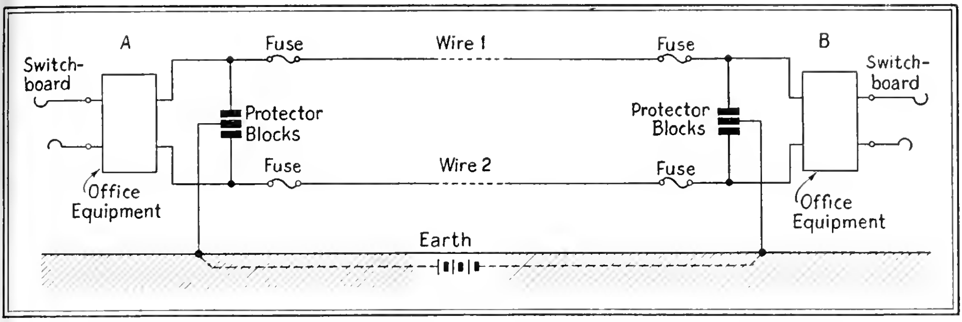
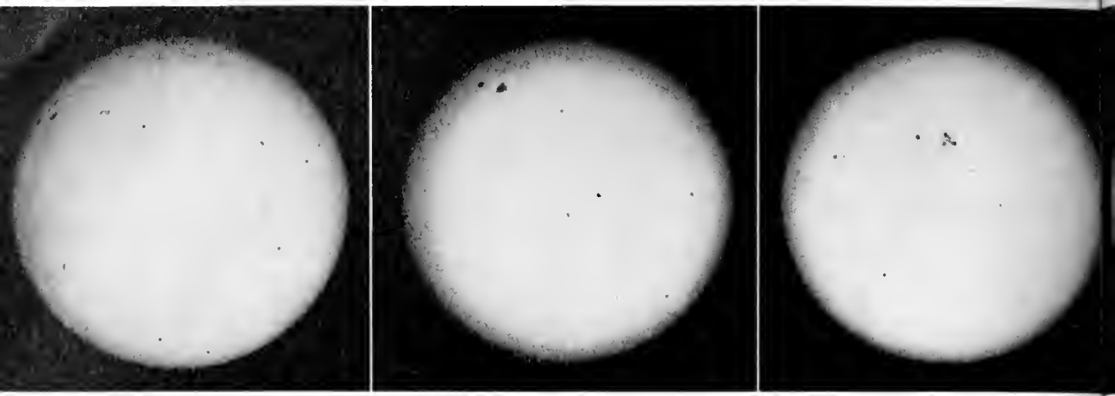


FIG. 3

Schematic representation of a simple telephone circuit, with protective arrangements and a high earth potential difference

point of communication.) Also, in the case of grounded communication circuits, which require for successful operation that differences in earth potential between the two ends of the circuit be kept relatively small, such periods of great solar activity and magnetic disturbances are likely to cause some reactions. A circuit operating on a metallic basis, for example, on a pair of wires, is not affected unless the difference in ground potential between the two ends of the circuit exceeds the insulation strength of the circuit to ground. The breakdown of the insulation to ground would render the circuit unserviceable. In some cases this would result in permanent damage unless the circuit were equipped with protective apparatus such as carbon block protectors, which are designed to have a lower strength to ground than the circuit to be protected. The way in which these protectors act is described in the following paragraph.

Figure 3 shows the diagram of a telephone circuit operating on a metallic basis between points A and B and with carbon block protectors at each end. If a voltage is built up on the wires, due either to lightning or the presence of some other source of foreign potential, it breaks across the small gap between the carbon blocks and escapes to ground. Such high potentials are thus diverted from the central office equipment. A peak voltage of about 450 volts between line wires and ground is required, on the average, to break down the protectors in this manner (minimum of about 350, maximum of about 575 volts). When high earth potentials exist, the protector blocks operate in a reverse manner. In this case a high potential between points A and B, which may be represented by a battery connected between the two grounded blocks as shown in Figure 3, will break across to the blocks connected to the line wires. Depending upon the particular circuit terminating conditions, the breakdown of gaps due to ground potential requires on the average about 450 volts and in many cases as much as 750 volts, particularly when two sets of protector blocks are in series.



U. S. NAVAL OBSERV

March 21 *March 22* *March 25*

FIG. 4

Sun spots: Photographs of the solar disc on six days last March

What Happened on March 24

But now, let us return to a consideration of what occurred on March 24. Magnetic records made at the United States Coast and Geodetic Observatory at Cheltenham, Maryland, show that the storm began at 8:50 A.M. (Eastern Standard Time) March 24. At 10:45 A.M. an unusually violent period began, reaching its maximum about 12:00 noon and continuing until about 2:00 P.M. A high degree of magnetic activity persisted until about 9:00 A.M. on March 25. Unusual displays of aurora borealis were seen on the night of March 24, being visible as far south as Tucson, Arizona. A moderately large group of sun spots was present on the central disc of the sun during the storm. This can be seen from Figure 4, which is a succession of photographs taken of the solar disc on days just before and just after the period of greatest disturbance. Reports from various observatories throughout the world indicate that, considering both intensity and duration, the storm of March 24 will probably be remembered as one of the greatest of magnetic disturbances.

With respect to land line communications, it is interesting to note that the times when reactions started, when the maximum reactions occurred, and when, in general, they ceased, corresponded closely with the indications of the magnetic records of the observatory at Cheltenham. The earliest report of trouble on land lines came at about 9:00 A.M., E.S.T. By 10:00 to 10:30, E.S.T., reports of trouble were indicated from widely separated points in Ontario, Canada, Connecticut, Minnesota, and on the Pacific Coast. Generally, the troubles throughout the country reached the peak from about 11:30 A.M. to 3:00 P.M., E.S.T. Relatively few troubles were encountered after about 4:00 P.M., E.S.T., March 24. Most of these troubles involved the operation of protective equipment, which opened or grounded the circuits. Some reactions on land line services were reported in the United States in all except a few southern states. Similar reactions were reported from a number of points in Canada. A few cases of operation of carbon block protectors were noted, especially in Minnesota, in the morning hours of March 25.

Figure 5 indicates by small dots the points at which circuits of the A. T. & T. Long Lines Department were

SHINGTON, D. C.

March 26 *March 27* *March 28*

affected. The shaded portions represent areas in which, from a consideration of the geological structure of the earth, high earth resistivity would be expected to exist. This has been verified to some extent by actual measurement. As shown on Figure 5, almost the entire state of Minnesota falls in a high resistivity zone. Figure 6 is a map of Minnesota with dots representing points at which circuits of the Long Lines Department, the Northwestern Bell Telephone Company, the Tri-State Telephone and Telegraph Company, and connecting companies were affected by high earth potential differences.

In general, it was difficult to determine the maximum voltage experienced, since in some cases where measurements were attempted the protective apparatus operated and grounded the circuits involved. However, from at least one point (the Boston toll test room, as shown in the record for March 24—on page 193) have come indications that voltages in excess of 600 volts and probably as high as 800 volts negative and changing to 400 volts positive were experienced between two points about 75 miles apart.

Protector operation was reported on several circuits only 20 to 25 miles in length, indicating in these cases ground potential differences of at least 350 volts over these short distances. In general, throughout the sections of the country affected, the voltages fluctuated from positive to negative with intervals ranging from seconds to minutes.

For about two years the ground potential difference between Minneapolis, Minnesota, and Fargo, North Dakota, has been continuously recorded by an automatic recording system. The two portions of the chart from this system shown in Figures 7 and 8 rather completely illustrate the previous discussion. Figure 7 shows the potential difference to be near zero and varying relatively little until just before 9 A.M., E.S.T., on March 24, 1940 (the chart itself records Central Standard Time). At this time wide swings of the needle began and soon thereafter, as indicated by the zero recording near the end of the chart, the system went out of service due to operation of fuses and carbon block protectors and to subsequent testing activities on the circuit.

This recording system is grounded at Fargo and is equipped with carbon

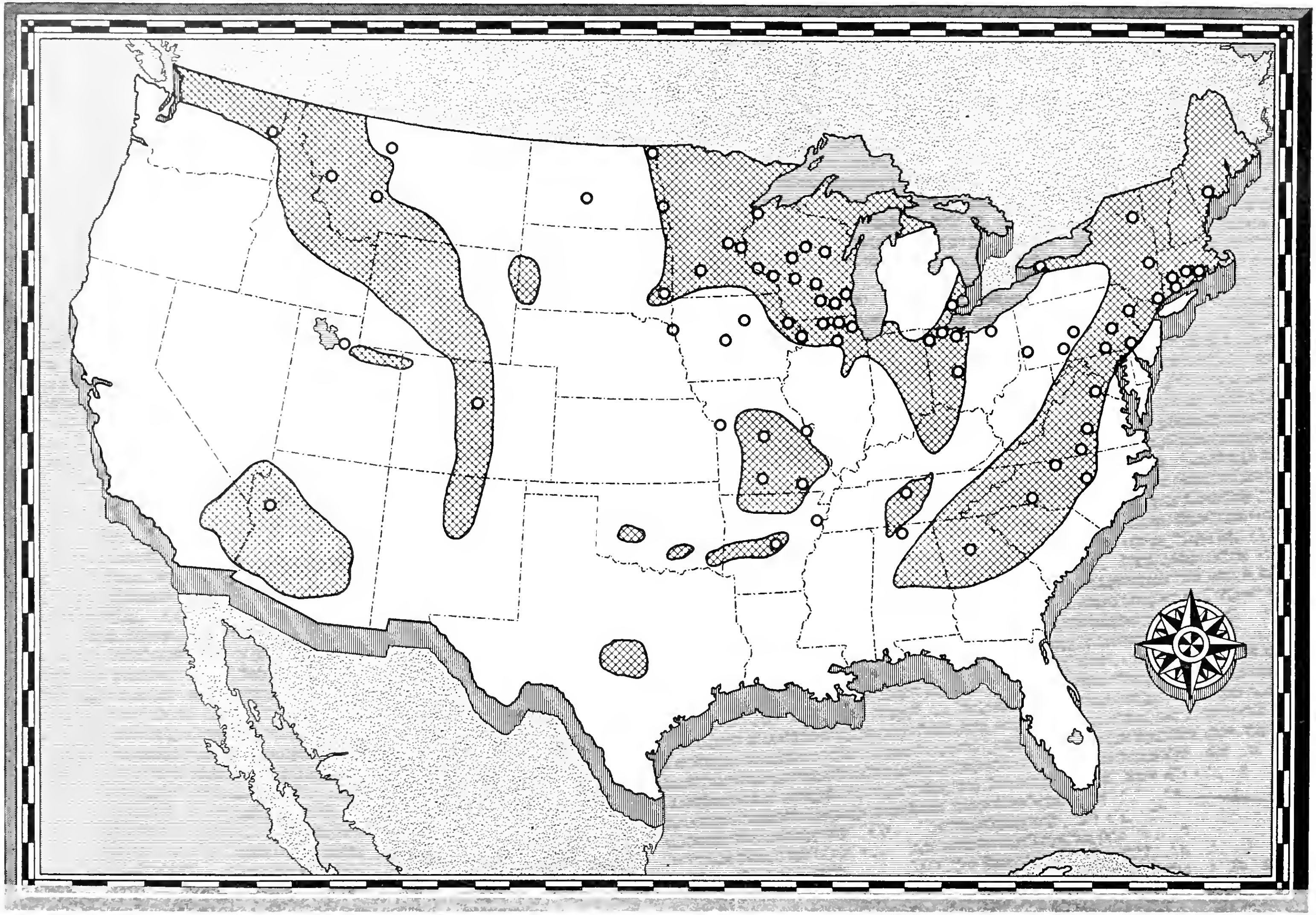


FIG. 5

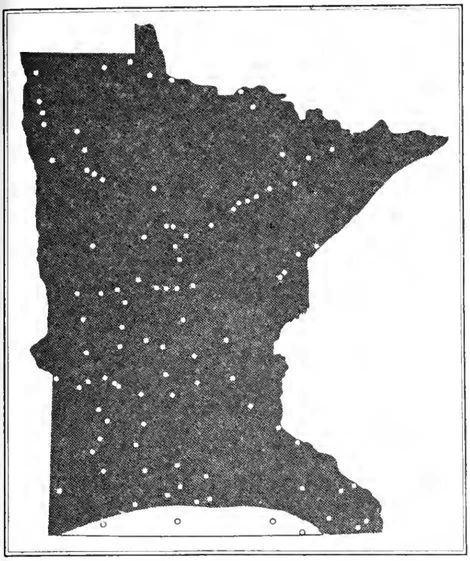


FIG. 6

A map of Minnesota similar to that opposite, the dots indicating where circuits of various telephone companies were affected by high earth potential differences

block protectors, so that it would be expected to go out of service, on the average, when the potential difference became as high as about 400 to 500 volts. The system would not, therefore, record the greatest potential differences encountered. While the severest effects of the storm occurred on March 24, the portion of chart in Figure 8 shows that on the morning of March 25, considerable potential differences were still occurring and were varying rapidly between positive and negative values. The carbon block protectors operated at about 5:15 A.M., E.S.T., at which time potential differences in the order of 400 volts were being recorded.

Nearly all overseas radiotelephone circuits and service to ships at sea were greatly affected. The short

Observations at Boston Toll Test Room

New England Tel. & Tel. Co.
March 24. 1940

9:30 A.M. Meter in grounded Keene line shows potential of 75 to 100 volts negative.

10:00 A.M. Put recording voltmeter on Keene line. Meter goes off scale (125 volt scale).

11:00 A.M. Put two 150 volt meters in series on Keene line. Both meters go off scale (over 300 volts).

11:30 A.M. Put 3 meters in series on Keene line. Potential varies from about 300 volts positive to 400 volts negative and goes off scale negative (over 450 volts). Put in 4th meter in series and watch.

11:35 A.M. About this time voltage creeps up to near 600 and finally goes off scale negative (over 600 volts). Needles stayed off scale for a period of about 4 to 5 seconds, then returned to about 300 volts. At this point 11 of the No. 74 type heater fuses let go on the Morse Battery panel.

The variation in ground potential as measured between Boston and Keene, and which started around 9 A.M., was very erratic, sometimes reaching as much as 400 volts positive and over 600 volts negative, which occurred around 11:30 A.M. It was this latter surge that caused 11 of the No. 74 type fuses to blow at one time in the Boston office. The operation of most of the heat coils and carbons probably took place at this time, as there was a strong odor of ozone at the frame directly after. The potential changed at the rate of about 100 volts per second and as we were not equipped to measure over 600 volts when the big surge came, it is possible, judging by the rate of change, that the voltage reached somewhere near 800 volts negative, as the needle went off scale at 600 volts and remained off for a period of 4 or 5 seconds. This would be about the time required to reach 800 volts and return to 600 volts again.

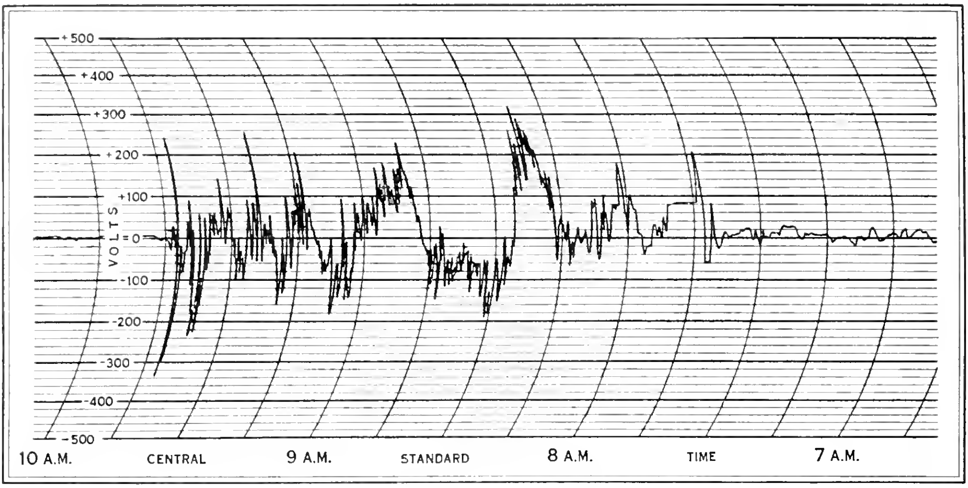


FIG. 7

The record of the ground potential difference between Minneapolis, Minn., and Fargo, N. D., on the morning of March 24, 1940

wave circuits on the transatlantic routes were interrupted on Sunday and a number of days thereafter. Figure 9 shows graphically the periods of interrupted service on the transatlantic route on March 24 and 25. Radiotelephone services to South America and across the Pacific were affected considerably less than those across the Atlantic, and service to the Caribbean region through Miami, and coastal and harbor radiotelephone services were practically free from interruptions. Radio disturbances

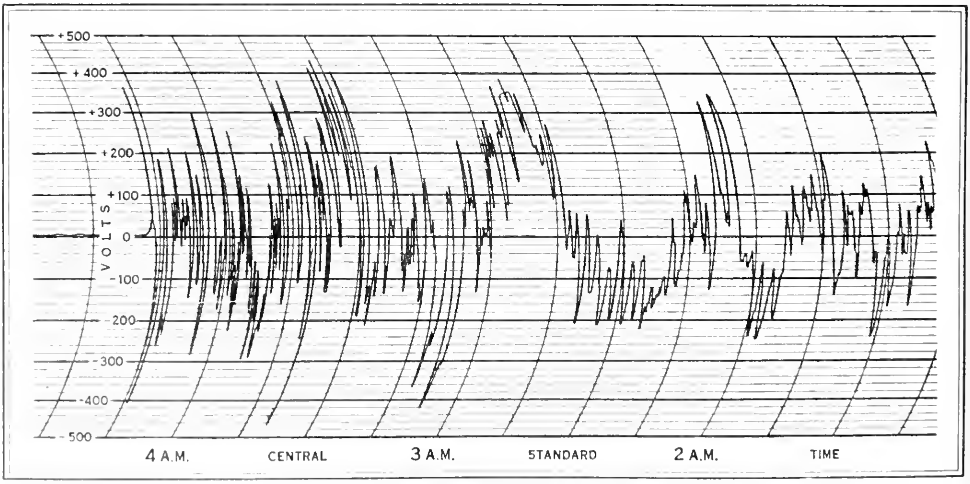


FIG. 8

The similar record on the following morning

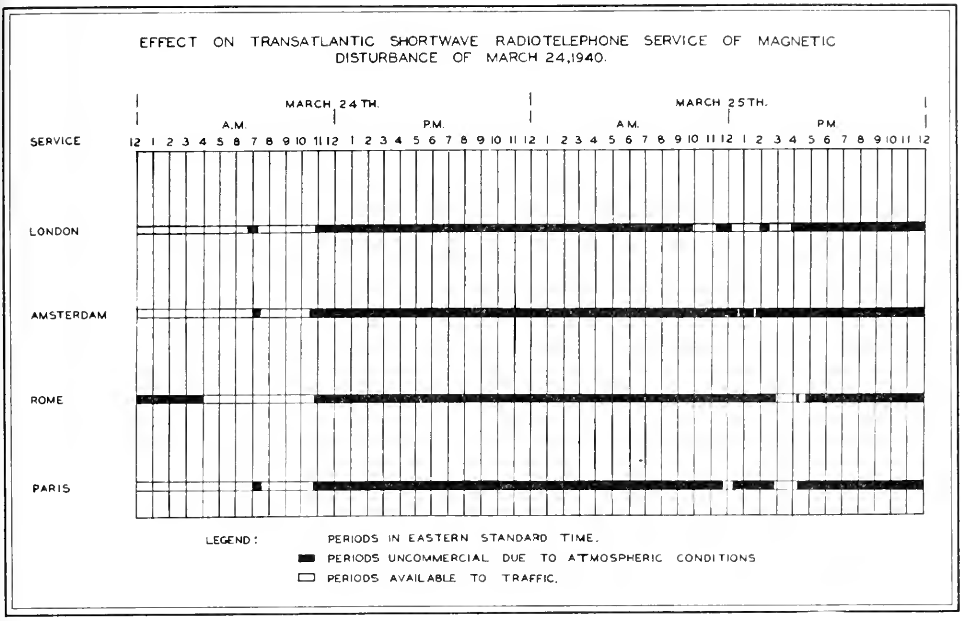


FIG. 9

Interruptions to transatlantic radiotelephone service on March 24 and 25

also increase towards the upper latitudes, which accounts for the greater effects on the transatlantic circuits.

Only a small portion of the telegraph services of the Bell System is normally handled over grounded telegraph circuits. Some of these services, which had not already been arranged to operate on a metallic or on a balanced wire basis, were affected for brief periods. Long distance telephone and telegraph circuits which were operated on a metallic basis were affected in the manner explained previously through the operation of protective equipment and the reduction in their insulation to ground. This included in some cases carrier systems which were operating on such metallic facilities. Some of the major network broadcasting facilities were affected at times by noise, cut-outs, and scratches, and in certain sections the means for reversing the direction of transmission on program facilities from a remote point was affected, making it necessary to resort to manual operation at intermediate points. Some of the effects of the magnetic storm were also experienced on the wire photo networks. Due to the relatively short distances involved in exchange area services, these services were not noticeably affected by the storm.

Actual Damage Was Slight

IN spite of many temporary interruptions and reactions on service, actual physical damage to plant or equipment was very small. In general, the protective apparatus in the wire plant functioned effectively and, although thousands of protector blocks were grounded, very little damage to telephone apparatus in the numerous central offices resulted. Individual circuit failures were matters of minutes, or at the most hours. Restoration of service was expedited by rapidly increasing the operating personnel, many of whom would not normally be working on Sunday.

The comparative rarity and short duration of great magnetic storms such as that which occurred on the 24th of March probably makes it impracticable to guard completely against their temporary effects. However, Bell System engineers are continuing their study of the record of this and other magnetic storms with a view to reducing or avoiding such reactions and thus further increasing the dependability of Bell System communication services.

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In this article the author has drawn on a number of sources concerning the general theory of magnetic storms and the specific reactions resulting from the storm of March 24. He acknowledges these, and also expresses his appreciation of the assistance of his associate, Mr. A. M. Dowling.

THE CONQUEST OF A CONTINENT

The Successive Means Which Have Been Devised for Coast-to-Coast Communication Have Been Fundamental to the Growth of This Country and to Its Unity as a Nation

By ROBERTSON T. BARRETT

Part I

The year 1940 marks the twenty-fifth anniversary of the opening of the first transcontinental telephone line, on January 25, 1915: an event which forms a part of what we Americans have come to call "the conquest of a continent."

The dramatic story of how that first coast-to-coast telephone line was conceived, planned, built, and officially put into service has been told elsewhere.* The place which the first transcontinental telephone line, and those which have followed it, hold in the over-all picture of communication across the continent has not, however, been discussed as fully. The present article has been prepared in the hope that it may afford a clearer understanding of the background for the drama which was enacted a quarter of a century ago when the human voice first spanned the distance between the Atlantic and the Pacific.

In Part I, it is proposed to discuss some of the social, political, and economic needs that have brought into being the instrumentalities of communication which, in succession, have been created as means of linking coast with coast. With a single exception (which does not deal with overland communication) the instrumentalities discussed in detail in Part I will be those which have not involved the use of steam, electricity, or other forms of invention more advanced than harness and wheel. Part II will deal with those means of communication which have been made possible by the application of invention and scientific research to the problems involved in this peaceful conquest of the North American continent.

This process has been a very long one. Its beginning was foreshadowed when, in 1513, Balboa made his way across the Isthmus of Panama, waded out into the waters of what we know as the Pacific and, raising his sword aloft, proclaimed:

> "Long live the high and mighty sovereigns of Castile! Thus in their names I take possession of these seas and regions."

A colorful and dramatic bit of play-acting, to be sure, but one that, viewed in retrospect, seems a bit fatuous. Seas are not so subdued; continents

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* "A Quarter-Century of Transcontinental Telephone Service," QUARTERLY, January, 1940.

are not so conquered. Not even by the march of armored conquistadores are they brought into subjection. Continents are won by the slow and often painful process of clearing wildernesses, establishing homes, building towns—and laying out roads and other facilities for communication which will link these towns with other towns.

Their Faces Ever Westward

THE importance of Balboa's exploit lay not in the picturesqueness of the ceremony but in the fact that he had provided evidence that there *was* another ocean to the westward of the continent which Columbus had discovered. From that moment onward, every explorer of the Atlantic coast of North America saw in each deep bay or wide river that he came upon a possible passage to the Pacific. From that moment, succeeding waves of white men who settled in what is now the United States became, as it were, continent-conscious. They thought of this new region to which they had come to make their homes as a place of vast distances, with a sea on either side. With the ocean that lay to its east the first settlers were all too familiar, for they had been months in crossing it. But the sea that lay to the west had the glamor of the unknown. It seemed to have for the white man an almost magnetic attraction. Partly through a desire for more "elbow-room," partly through economic pressure as opportunities for making a living were diminished by increasing population, more and more people turned their faces westward and began their march toward the Pacific.

Thus, as early as 1635, a company of emigrants from the Massachusetts Bay Colony set out for the Connecticut valley, impelled, John Winthrop tells us, by their lack of grazing lands, the danger that Connecticut would fall into other hands, and *"the strong bent of their spirits to remove thither."*

This westward urge was, indeed, in part spiritual in its nature, and not due entirely to economic or other material causes. It was born of the restlessness, the love of freedom, of those who are destined to become pioneers. It was a part of the stuff of which the American democracy was made. They who are prompted to seek wider geographic horizons are not easily satisfied with political horizons any narrower than those afforded by a government in which people, not potentates, are the rulers. This "strong bent of their spirits to remove" toward the Pacific was a potent factor in the making of America.

BUT these pioneers had another quality, hardly less spiritual than their desire for more breathing-space, more freedom. It was their determination *not* to be cut off entirely from that which they left behind as they turned their faces toward the west. Impelled by a sort of racial nostalgia, they turned the trails over which they marched into roads that would enable them to keep in touch with the friends in the regions whence they had come or through which they had passed. They thus laid what might be called the social foundations for an American communication system—a system which grew in extent and efficiency as needs increased during the passing years.

"THE STRONG BENT OF THEIR SPIRITS TO REMOVE THITHER"

The departure of a company of emigrants from the Massachusetts Bay Colony for the Connecticut valley in 1635. From a drawing made for the "Telephone Almanac" of 1929

There were political foundations, as well. Here in America there was destined to be brought into being a government not of emperors or kings or czars. It was to be ruled by the people. As Simeon Strunsky has written, in "The Living Tradition," it was to be held together by "one cohesive force which lies wholly outside the realm of steam and rail and wire, but has not failed to profit by such physical agencies. That was the binding force of an Idea. It was the spirit of union pervading the atmosphere of the Thirteen Colonies, the sense of common destiny, the feeling of participation in the building of a United States long before there was a United States."

This spiritual quality of a sense of nationhood, this instinct for interdependence, was one of the reasons why men first built roads, then inaugurated mail services by stage coach or pony express riders; why they invented telegraphs, telephones, and airplanes.

THESE communication facilities with which we Americans have spanned the continent, by transmitting ideas and thus affording a basis for informed public opinion, have played an important role in our national history. But to say this is not at all to imply that, by reason of them, all Americans ever have thought alike, or ever will.

In June, 1846—two years after Morse had transmitted his historic message, "What hath God wrought!"—a writer in the *New York Express* had this to say:

> "The power of the states will be broken up in some degree by this intensity of communication, and the Union will be solidified at the expense

> of the State sovereignties. We shall become more and more one people, thinking more alike, acting more alike and having one common impulse."

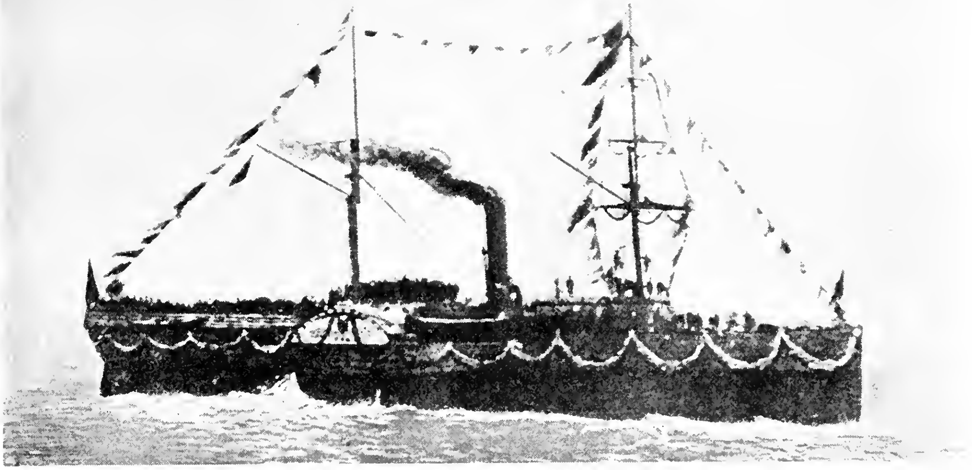
Yet within twenty years after that paragraph was written, a bitter war had been fought because Americans had definitely *not* come to think and act alike, and because the question of state sovereignty had distinctly *not* been settled. Even now, we Americans do not spend our time telephoning or telegraphing each other in regard to national issues. We frequently avail ourselves of the privilege of turning off the radio when a political speaker irritates or bores us. Certainly we do not ride from New York to California by rail or airplane merely to find out what people on the Pacific coast think of the latest questions before Congress. And if we did, we would still exercise the democratic right of adhering to our own opinions. Yet the fact remains that the very existence of these nation-spanning systems of communication does give us a sense of national solidarity, just as a telephone in one's bedroom gives one a sense of security, though it may never be used to call the police to arrest a burglar who is prowling around downstairs. Potentially, as well as actually, these communication services are national assets of incalculable value.

Pioneering and Economics

But if the early forms of communication, and those which have followed them, were brought into being in part for social reasons, and in part for political reasons, they were brought into being much more certainly for economic reasons. Every new region into which these westward-marching pioneers penetrated became simultaneously a source of supply of products which had to find a market, and a place of consumption for products from the areas already settled and developed industrially. Over such highways as Pennsylvania's Lancaster Turnpike, for instance, went many hundreds of passengers, and many pounds of mail. But over them, too, toward the Alleghenies and back from them, went tons and tons of freight.

It was the function, or one of the functions, of these communication facilities, to move goods to market; to make available the necessities or the luxuries which a rising standard of living demanded. It is still true that our common carriers transport far more freight than passengers. It is certainly true that, as to long distance service in particular, the great bulk of telephone traffic is made up of conversations in regard to business. Except at holiday times, most telegrams are sent from and to business houses. America has her nation-wide communication systems because the needs of commerce and industry, as well as needs that are social and political in their nature, demand such systems, and can be met with nothing less.

In the present article let us consider the process of evolution by which these needs have arisen, and the parallel process of evolution by which communication facilities have, in turn, been brought into being to meet them. We must confine our discussion to organized systems of communication, excluding more than a brief reference to such exploits as that of Lewis and Clark, and the overland journeys of the parties sent to the Pacific by the



THE STEAMSHIP *CALIFORNIA*

This was the first mail steamer to reach the Pacific coast, sailing from New York on October 6, 1848, by way of Cape Horn and arriving at San Francisco on February 28, 1849. She and two other vessels of the Pacific Mail Steamship Company carried mail on the Panama–San Francisco–Astoria route. From "The Pioneer Steamer California," by Victor M. Berthold

shrewd Astor, which were not primarily intended as communication projects.

It has been difficult for most writers on the history of communication in America to resist the temptation to elaborate on that which has been colorful and romantic. They have thought in terms of ceremony rather than of service; of the driving of golden spikes, rather than of the carrying of mails, passengers, and freight as a matter of daily routine. They have pictured the drama of Pony Express riders, thundering across the plains, amidst showers of Indian arrows, and too often overlooked the need which the rides of these dauntless couriers were intended to meet.

Let us, for our present purposes, approach the matter somewhat more prosaically—from the standpoint, as has been indicated, of the needs which, in turn, have brought these transcontinental communication services into being; the manner in which these needs have been met; the success of each particular service, in terms of its value in proportion to cost, and as measured in speed of service, efficiency, dependability, and general usefulness.

Mails across the Isthmus

But to return to the Isthmus of Panama. By one of those curious coincidences with which history is filled, it was across this narrow neck of land, which separates the northern and southern portions of our hemisphere, that the first organized communication service between the Atlantic and

Pacific coasts of the United States was inaugurated.

Astor's fur traders had established a settlement in the Pacific Northwest, which they named Astoria in his honor, as early as 1811. Other settlers had followed them. The "Oregon question" had been bitterly argued with England, and finally settled in 1846, and in a message dated August 5 of that year, President Polk had said:

> "It is important that mail facilities, so indispensable to the diffusion of information, and for binding together the different portions of our extended Confederacy, should be afforded to our citizens west of the Rocky Mountains."

To meet the need thus voiced, and also the need for building up a fleet of steam merchant vessels which might be converted into fighting ships in case of necessity, an act of Congress was passed, and approved on March 3, 1847, providing for the building of four such vessels. It directed the Secretary of the Navy to contract for the transportation of the United States mails from New York to Chagres, on the Atlantic side of the isthmus, and back, twice a month, for compensation not to exceed $290,000 per annum. He was also authorized to contract for the transportation of mail from Panama to some port in the territory of Oregon, once a month each way. This mail was to be transported in either steam or sailing vessels. Such a contract was made and later assigned to William H. Aspinwall, for a compensation of $199,000 per annum. Aspinwall incorporated the Pacific Mail Steamship Company, which built three steamers for service between Panama and Oregon. The first of these started from New York October 6, 1848, to make its way to the Pacific, by way of Cape Horn. It reached San Francisco on February 28, 1849.

Meanwhile, gold had been discovered in California, thousands of prospectors were crowding into the new El Dorado, and the communication needs of the Pacific coast had thereby been rendered vastly more urgent.

The first mail was transported across the Isthmus of Panama by the New Grenada government at twelve cents a pound. As it was light in volume, it was carried by canoes and on muleback. Later, the Panama Railroad was built, and a contract made with it in 1851 for compensation at the rate of twenty-two cents a pound. In April, 1857, the contract was modified to an annual compensation of $100,000.

The First Pacific Mail Steamers

THE first steamers, in 1849, carried about 6,000 letters, and a large volume of newspaper mail, on each trip. In 1850, about 50,000 letters was the monthly average. In July, 1852, they reached what is said to have been the monthly high of 60,000 letters. The arrival of the mail steamers in California was hailed with enthusiasm by the inhabitants, and newspapers from the east (although weeks old) brought prices which could have been paid only in a land where gold was cheap.

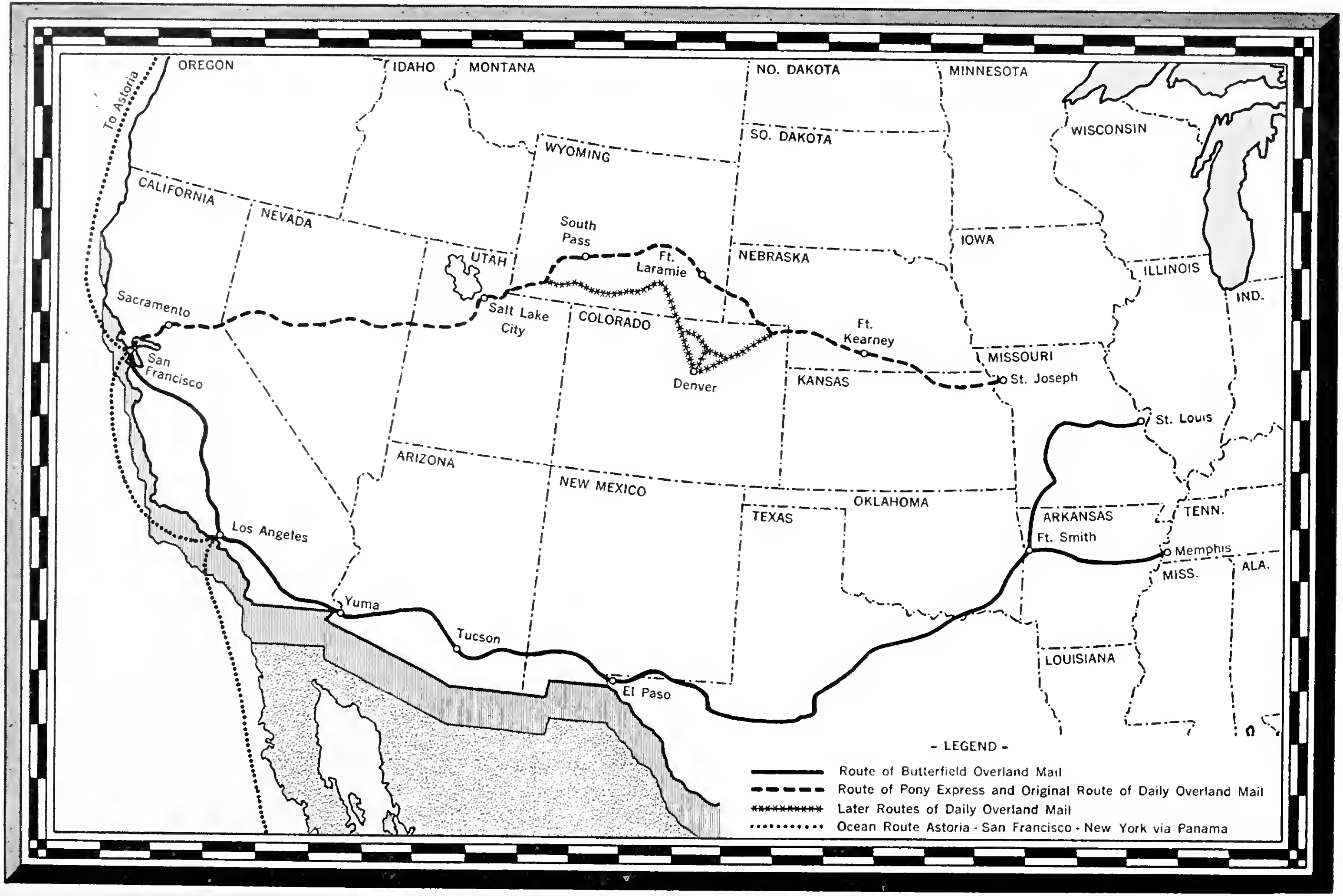
The first rate of postage to the Pacific, provided by an act of March 3, 1847, was forty cents for single letters. General reductions in the postal rate went into effect in 1851, and the rate to California was reduced to six

WAITING FOR MAIL IN SAN FRANCISCO

This old picture shows a crowd before the post office about the year 1849. Mail from the East was carried by steamer from New York to Chagres, across the Isthmus of Panama by canoe and mule-back (later by railroad), and again by steamer to San Francisco

cents. This was raised to ten cents in 1855 and remained at that figure until 1863.

THE mails which were carried to and from the Pacific coast by way of Panama were usually about a month in transit. In February, 1858, what seems to have been a record between New York and San Francisco was established when the steamer *Golden Age* reached the latter city with mails that had left the dock in New York twenty-one days, two hours and thirteen minutes before. This really commendable speed record compares most favorably with the best that was credited to the next form of communication across the continent—the famous Overland Mail, which supplemented it but did not supplant it. The relative permanence of the service by steamship was assured by its ability to handle large volumes of newspaper and other mail which did not require speed of transmission and which could not be handled efficiently or economically by other means of transportation that were in use prior to the building of the first transcontinental railroad.



PRINCIPAL PASSENGER AND MAIL ROUTES BETWEEN EAST AND WEST, 1849-1869

The Overland Mail

Indeed, it seems certain that the necessity for greater speed was not the controlling factor in bringing about the establishment of the Overland Mail. Service by steamship, although expensive, had met rather effectively the needs of both the eastern and western coasts of the continent. It did not so well meet the needs of the rapidly developing region that lay in the basin of the Mississippi. More particularly, so far as the eastern seaboard was concerned, it was of especial advantage to the industrial North, where abolitionist theories were gaining strong foothold; it was of far less value to the cotton-raising, slave-holding South. Issues between North and South were becoming more acute, and each was eager to strengthen its ties with the more remote western sections of the country, and particularly with California, which, in the event of open conflict, could supply vast quantities of gold to that side with which it might cast its lot. These facts, it seems certain, explain in part the establishment of the Overland Mail—and go far toward explaining the circuitous route which, as we shall see, its coaches followed between St. Louis and San Francisco, far to the south of a more direct line between these two termini.

A route even more essentially southern had been established a year before the Overland Mail went into operation—that which connected San Antonio, Texas, with San Diego, California, by way of El Paso. Although ostensibly a stage line, its route was in many places almost impassable on wheels, and as late as September, 1858, passengers and mails were being carried between Fort Yuma and San Diego on muleback. When the Overland went into operation, in that same month, it followed the route of the San Antonio-San Diego line between El Paso and Fort Yuma.

Agitation which led to the establishment of the Overland Mail, growing out of discussions of the possibility of a railroad to the Pacific, began as early as 1855. Two years earlier, Congress had authorized surveys of five alternative transcontinental railroad routes, but nothing came of the project until, as we shall see, the Union Pacific was completed, in 1869.

The data obtained in these railroad surveys, however, furnished impetus to the idea of an overland mail stage service, and provided ammunition for the proponents of one proposed route or another. A petition for such a route was signed by 75,000 residents of California in April, 1856, and the people of Missouri were not less enthusiastic. Overland Mail bills failed in 1855 and 1856, and the proposal was debated heatedly in several successive sessions of Congress.

Finally, on March 3, 1857, amendments to the Post Office Appropriation Bill contained provisions for the establishment of a service "from such point on the Mississippi River as the contractors may select, to San Francisco, at a cost not exceeding $300,000 per annum for semi-monthly, $450,000 for weekly or $600,000 for semi-weekly mails, at the option of the Postmaster General."

The service was to be provided in "good four-horse coaches or spring wagons" and was to be performed within twenty-five days for each trip. The contractors were given the right to preempt 320 acres of any land not disposed of or reserved at each point necessary for a station, which stations were to be not nearer than ten miles from each other.

Controversy as to the selection of the route was not settled by the passage of the act. Under the law, the contractors had the right to select the route—but the Postmaster General selected the contractors. A Tennesseean, and strong in his pro-southern opinions, Postmaster General Brown selected a route "from St. Louis, Missouri and from Memphis, Tennessee, converging at Little Rock, Arkansas; thence via Preston, Texas, or as nearly so as may be found advisable, to the best point of crossing the Rio Grande, above El Paso, and not far from Fort Fillmore; thence, along the new road being opened under direction of the Secretary of the Interior, to Fort Yuma, California; and thence, through the best passes and along the best valleys for safe and expeditious staging, to San Francisco."

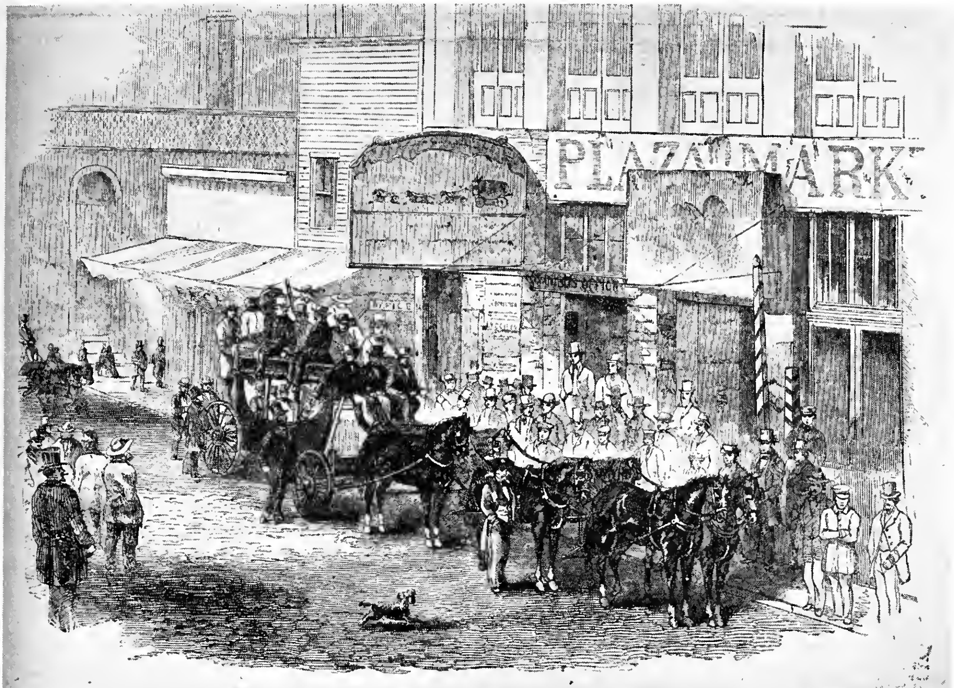
The contract was awarded to John Butterfield and six associates for a semi-weekly mail at an annual compensation of $600,000. The service became one of the few of national importance to which the name of an individual was commonly attached. It was almost universally known as the Butterfield Overland Mail.

So outspoken was the criticism of the route selected, of which the total length was 2795 miles, that the Postmaster General devoted considerable space, in his annual report for 1857, to a justification of his action in giving it preference over other routes. At its most southern point, it dipped about 600 miles below the more direct route through South Pass in Wyoming, and was derisively called the "oxbow" or "horseshoe" by one New York paper.

The Service Inaugurated

Although opinions differed as to the wisdom or fairness of the selection of the route, the formal inauguration of the Overland Mail service, on September 15, 1858, was greeted everywhere with enthusiasm. The first eastbound trip reached St. Louis in twenty-three days and four hours; the westbound trip was made in twenty-four days, eighteen hours and twenty-six minutes.

At first, Concord coaches were used, accommodating four passengers and their baggage and 500 or 600 pounds of mail. Later, more commodious coaches were introduced, carrying six to nine inside passengers and as many as ten outside passengers. When service was inaugurated, the passenger fare was $100 for the through eastward trip and $200 from Memphis or St. Louis to San Francisco. Later, the eastward through fare was raised to $200, then lowered to $150. The differential between eastward and westward fares was due to the fact that most of the demand for passage was from travelers bound for California, many of whom went there to remain permanently. Mail was carried at the rate of one-half ounce for ten cents. By 1860 the Overland Mail was carrying more first-class postal matter than the Panama line of mail steamers. At the height of its prosperity, the Overland had about



THE OVERLAND MAIL STARTING FROM SAN FRANCISCO FOR THE EAST.—[FROM A PHOTOGRAPH.]

STARTING A TRIP OF THE OVERLAND MAIL
Reproduced from "Harpers Weekly" of December 11, 1858

one hundred coaches, seven or eight hundred men—of whom about 150 were drivers—and about 1500 horses and mules.

There was never any serious criticism of the operation of the Overland Mail, either as to speed or dependability. But the choice of the southern route continued to be a subject of controversy. Advocates of the central route continued to point out that the southern route was not only circuitous, but that at certain points the problem of providing water and pasturage for horses and mules was a serious handicap. Meanwhile, the political issues out of which this controversy grew were becoming more sharply drawn. Congressional majorities were shrinking into minorities; minorities were becoming majorities. Differences between the North and South were approaching an open break.

Hardly more than a month before Fort Sumter was fired upon, Congress ended the career of the southern route of the Butterfield Overland Mail. On March 2, 1861, presidential approval was given to an act authorizing the Postmaster General to discontinue the service over the southern route and to provide for the conveyance, by the same parties, of a six-times-a-week mail by the central route, that is, "from some point on the Missouri River, connecting with the east, to Placerville, California."

But this decision, so clearly reflecting the stirring political events of the time, had not been made until the practicality of the central route had been demonstrated by one of the most picturesque and romantic of all forms of transcontinental communication—the famous Pony Express.

The Pony Express

Curiously enough, the Pony Express had been in operation almost a year, as a private enterprise, when the above mentioned act of March 2, 1861, gave it governmental support and sanction. It had been inaugurated, if not conceived, by William H. Russell, of the firm of Russell, Majors and Waddell, who were operating a semi-monthly mail line from the Missouri River to Placerville, via Salt Lake City. It seems to have been intended not only to provide speedy service to the Pacific coast, but to demonstrate the practicality of the central route, in the hope that to this route might be transferred the Overland Mail then being handled by Butterfield and his associates over the southern route. Doubtless one of the motives which prompted Russell and his associates to undertake the project, which they did at first at their own expense, was the hope that they might eventually receive the Overland Mail contract. Few enterprises as daring as theirs are undertaken without consideration of the much discussed "profit motive."

Russell seems to have been prompted to take the step which resulted in the establishment of the Pony Express in a conference with Senator William M. Gwin, of California, who contended that it was necessary to prove the feasibility of the central route before he would be able to persuade Congress to authorize a contract over that route in preference to the existing southern Butterfield route.

Be that as it may, Russell, with some difficulty, persuaded his partners to join him and on January 27, 1860, announced that he had decided to establish the Pony Express line. Preparations for the inauguration of the line got under way at top speed, and by March 17 advertisements appeared in San Francisco papers announcing that service would begin on April 3. The announcement added that the schedule time from San Francisco to New York was: for telegraph dispatches—which were carried, of course, only between the two terminal points of the telegraph lines—nine days; for letters, thirteen days. The announced rates for both letters and telegraph dispatches were: between San Francisco and Salt Lake City, three dollars per half ounce and under, and to all points beyond Salt Lake City, five dollars per half ounce and under, and at these rates according to weight.

Without going too minutely into details, the route may be described as running westward from St. Joseph, Mo., via the valley of the Platte River to Fort Kearney, Julesburg, Fort Laramie, South Pass, and Fort Bridger, to Salt Lake City. From this point it ran, a little south of due west, through Carson City, over the Sierra Nevadas to the south of Lake Tahoe, to Placerville, and thence to Sacramento. From this point the mail was taken by boat to San Francisco.

THE PONY EXPRESS

From an oil painting by N. C. Wyeth owned by the American Telephone and Telegraph Company and used in its national advertising twenty-eight years ago

A way bill of the first westward trip shows that the mail left St. Joseph at 6:30 on April 3, as announced; reached Salt Lake City at 6:30 on the ninth; Carson City at 2:30 on the twelfth; Placerville at 2:30 on the thirteenth; Sacramento at 5:30 on the same day; and San Francisco, 1:00 a.m. on the fourteenth. For the first time in history, mails had covered half the width of the continent in a little over ten days.

Figures on the volume of mail handled by the Pony Express riders are difficult to obtain. It is stated that on an average, forty-one letters per trip were carried to the Pacific coast between November, 1860, and April, 1861. From April, 1861, to July of that year, the average was sixty-four, and from that date to the termination of the service in October, 1861, the average was ninety. The east bound mail seems to have been much heavier in volume. In April, 1860, 205 letters were sent eastward by a single express.

As has been stated, the original rate for through messages was $5.00 per half ounce or fraction thereof. In August, 1860, and thereafter, one-fourth ounce letters were carried for $2.50 each. In April, 1861, the rates were reduced to $2.00 per half ounce. After July 1, 1861, the rate for half-ounce letters was reduced to $1.00.

As a financial enterprise, the Pony Express did not succeed. It seems obvious enough, from an examination of the rates above quoted, together with figures as to volume of traffic, that there must have been much truth in the statement of Alexander Majors, one of Russell's partners, that "the business transacted over this line was not sufficient to pay one tenth of the expenses, to say nothing about the capital invested." The initial cost of equipping the line has been stated to have been $100,000; the cost of maintenance, $480,000; additional expense due to the Washoe Indian War in Nevada, in which stations were burned and stock driven off by savages, $75,000; and miscellaneous expenses, $45,000, making a total of $700,000. All of these expenses were borne by the Russell firm up to the time when the act of March 2, 1861, became effective. In addition to providing for the carrying of a daily stage mail over the central route, this law provided for a semi-weekly Pony Express, and thus gave the Russell enterprise a belated blessing. The compensation for the joint undertaking was fixed at $1,000,000 per annum.

IRONICALLY, the contract for operating the Pony Express was not awarded to Russell and his associates, though they had operated the enterprise, at their own expense, with conspicous success—from the standpoint of demonstrating the practicality of the central route, which seems to have been one of its main purposes. The Butterfield concern was given the contract for both the overland mail and the Pony Express. An arrangement between the Butterfield and Russell organizations was made, however, under which Russell and his partners operated the Pony Express and the daily mail coach service from the Missouri to Salt Lake City and the Overland Mail (Butterfield) Company operated the service from Salt Lake City westward. The law specifically provided that the Pony Express service should be continued only until the completion of the Overland telegraph. As we shall see, this took place in October, 1861.

A Precious Heritage

IT is not within the purpose of the present article to dwell at length on the heroism of the Pony Express riders, or to pay tribute to the originators and operators of the line for the service which they performed in operating it. On this point it may perhaps be sufficient to quote from "The Overland Mail" by LeRoy R. Hafen:

> "From the standpoint of the nation, the Pony Express was eminently successful. It demonstrated the practicability of the Central route and marked the path for the first transcontinental railroad. By shortening the distance between the Atlantic and the Pacific coasts it helped to unite the Pacific and the Rocky Mountain region to the Union during the first ominous year of the Civil War. It showed the conquest of the West in one of its most spectacular phases, and is an act in the great Western drama that will always be recalled as one of our most precious heritages."

With the last trips of the Pony Express riders, the era of which they were the most glamorous exponents came to a close, and a new era began—the era of which the mechanization of means of speeding the written word, and later the spoken word, was to be the keynote. The instrumentalities of transcontinental communication which belong to this era of steam and electricity will be considered in Part II of this study.

(To be concluded)

TELEPHONE STATISTICS OF THE WORLD

Figures from the Most Complete Survey of its Kind—Which Show, Incidentally, the High Development of Facilities and the Frequency of Use of the Service in the United States

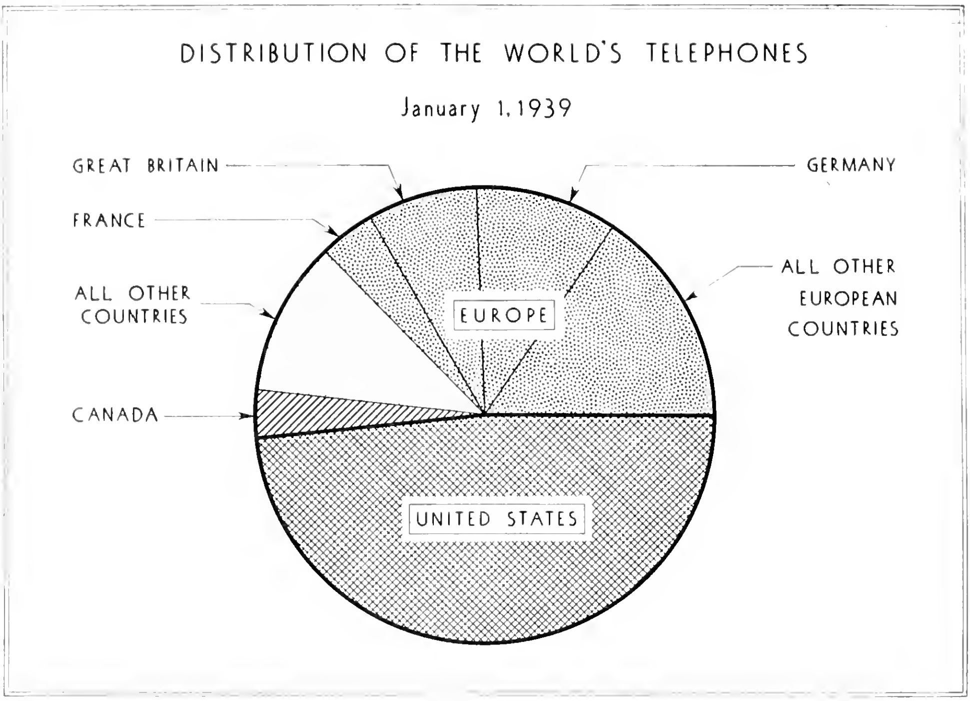
By KNUD FICK

On the basis of official statistics with respect to the telephone systems in this country and abroad as of January 1, 1939, it may safely be estimated—with allowance for war-time conditions—that more than 43,000,000 telephones are in service throughout the world at the present time. Nearly two-fifths of these telephones are owned and operated by the Bell System in the United States, and more than 93 per cent of all telephones in the world can be reached (except for war restrictions in some foreign countries) from any Bell System telephone. On the basis of present calling rates, approximately 65,000,000,000 local and long distance calls per year are made over the world's telephones.

The latest complete data regarding world telephone facilities were recently published by the American Telephone and Telegraph Company in a pamphlet entitled "Telephone and Telegraph Statistics of the World, January 1, 1939." This publication, the most complete survey of its kind, is based upon extensive information gathered by the Chief Statistician's Division from the organization or organizations, private or governmental, which operate telephone or telegraph systems in each foreign country. A number of tables and charts shown in that pamphlet are reproduced in the following pages.

During 1938, the total number of telephones in the world increased some 4.7 per cent, from 39,245,069 to 41,090,347. Slightly over 53 per cent of all telephones on January 1, 1939, were connected to automatic exchanges, including 9,150,000 dial telephones in this country. Associated with the total of 41,090,347 telephones were 174,548,000 miles of telephone wire, some 6,000,000 miles more than the year before, and equivalent to more than 400 feet of wire for every one of the world's inhabitants. The United States, with 19,953,263 telephones, accounted for 48.56 per cent of the world's total number of instruments and for 53.20 per cent of the world's telephone wire, although this country has only 6 per cent of the total number of people in the world.

On January 1, 1939, Europe, with 4½ times the population of the United States, had a total of 15,305,459 tele-



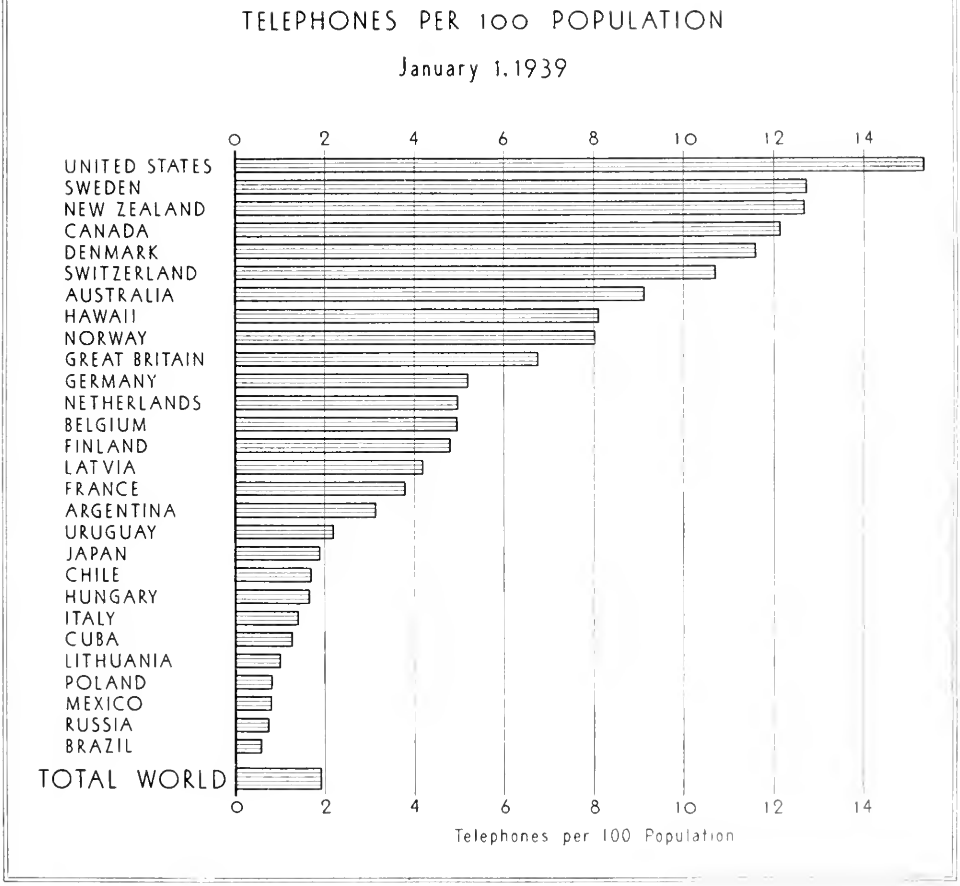
phones (including 9,840,000 dial telephones) and 59,033,000 miles of telephone wire, representing 37.25 and 33.82 per cent, respectively, of the world totals of telephones and wire. In the United States, there was an average of 4.65 miles of telephone wire per telephone, compared to 3.86 miles per telephone in the world outside the United States.

About three-fifths of the world's telephones were owned and operated by private companies, including 4,548,726 privately operated telephones outside the United States. Nearly 81 per cent of the 16,588,358 telephones in government-owned systems were in Europe.

Referring to the table "Telephone Development of the World, by Countries," it will be seen that the largest national telephone systems outside the United States, in the order of their size, were in Germany, Great Britain, France, Japan, Canada and Russia, these being the only countries with more than a million telephones each. In order to make allowance for the differences in the sizes of the various nations, telephone development is conventionally expressed as a ratio between population and number of telephones. A glance at the chart headed "Telephones per 100 Population" will show that the foreign countries with large telephone systems are not necessarily those with the most telephones in relation to population. Thus, the countries where the number of telephones correspond to more than 10 per cent of the population were, in the order of relative development, the United States, Sweden, New Zealand, Canada, Denmark and Switzerland.

The United States had 15.37 telephones per 100 population, a telephone development 21 per cent better than the next highest ranking system.

In this connection it is of interest to note that the largest five telephone systems operating wholly or predominantly under private ownership (namely, those in the United States, Canada, Italy, Denmark and Argentina) had an over-all telephone development of 11.38 telephones for each 100 of their combined population, compared with an aggregate development of 2.81 telephones per 100 population for the largest five countries in which telephone service is operated by a department of the national government. These latter countries (Germany, Great Britain, France, Japan and Russia) contain, in the aggregate, one-fifth of the world's population, or more than twice as many people as are served by the largest five private systems. The latter systems, however, have twice as many telephones in service. Telephone wire similarly averaged 0.55 miles per capita in the five privately owned systems and only 0.11 miles per capita



TELEPHONE DEVELOPMENT OF THE WORLD, BY COUNTRIES, JANUARY 1, 1939

Countries	Number of Telephones: Government Systems	Private Companies	Total	Per Cent of Total World	Telephones Per 100 Population
NORTH AMERICA:					
United States	—	19,953,263	19,953,263	48.56%	15.37
Canada	205,846	1,153,571	1,359,417	3.31%	12.13
Central America	13,131	17,999	31,130	.07%	0.40
Mexico	1,337	157,232	158,569	.39%	0.81
West Indies—					
Cuba	610	53,543	54,153	.13%	1.29
Puerto Rico	531	15,170	15,701	.04%	0.86
Other Places in the West Indies	9,042	18,838	27,880	.07%	0.36
Other Places in North America	—	17,014	17,014	.04%	4.40
Total	230,497	21,386,630	21,617,127	52.61%	11.85
SOUTH AMERICA:					
Argentina	—	405,474	405,474	.99%	3.13
Bolivia	—	2,595	2,595	.006%	0.08
Brazil	1,000	255,467	256,467	.62%	0.59
Chile	—	78,119	78,119	.19%	1.69
Colombia	8,500	30,333	38,833	.10%	0.44
Ecuador	4,276	3,050	7,326	.02%	0.29
Paraguay	—	3,339	3,339	.01%	0.35
Peru	—	29,318	29,318	.07%	0.43
Uruguay	34,810	11,846	46,656	.11%	2.20
Venezuela	702	23,102	23,804	.06%	0.67
Other Places in South America	3,018	—	3,018	.007%	0.54
Total	52,306	842,643	894,949	2.18%	1.00
EUROPE:					
Belgium	415,522	—	415,522	1.01%	4.95
Bulgaria	29,576	—	29,576	.07%	0.46
Denmark	18,607†	424,391	442,998	1.08%	11.61
Finland	7,720	177,736	185,456	.45%	4.79
France	1,589,595	—	1,589,595	3.87%	3.79
Germany†	4,146,489	—	4,146,489	10.09%	5.20
Great Britain and No. Ireland	3,220,241	—	3,220,241	7.84%	6.77
Greece	6,273	43,599	49,872	.12%	0.71
Hungary	164,572	790	165,362	.40%	1.64

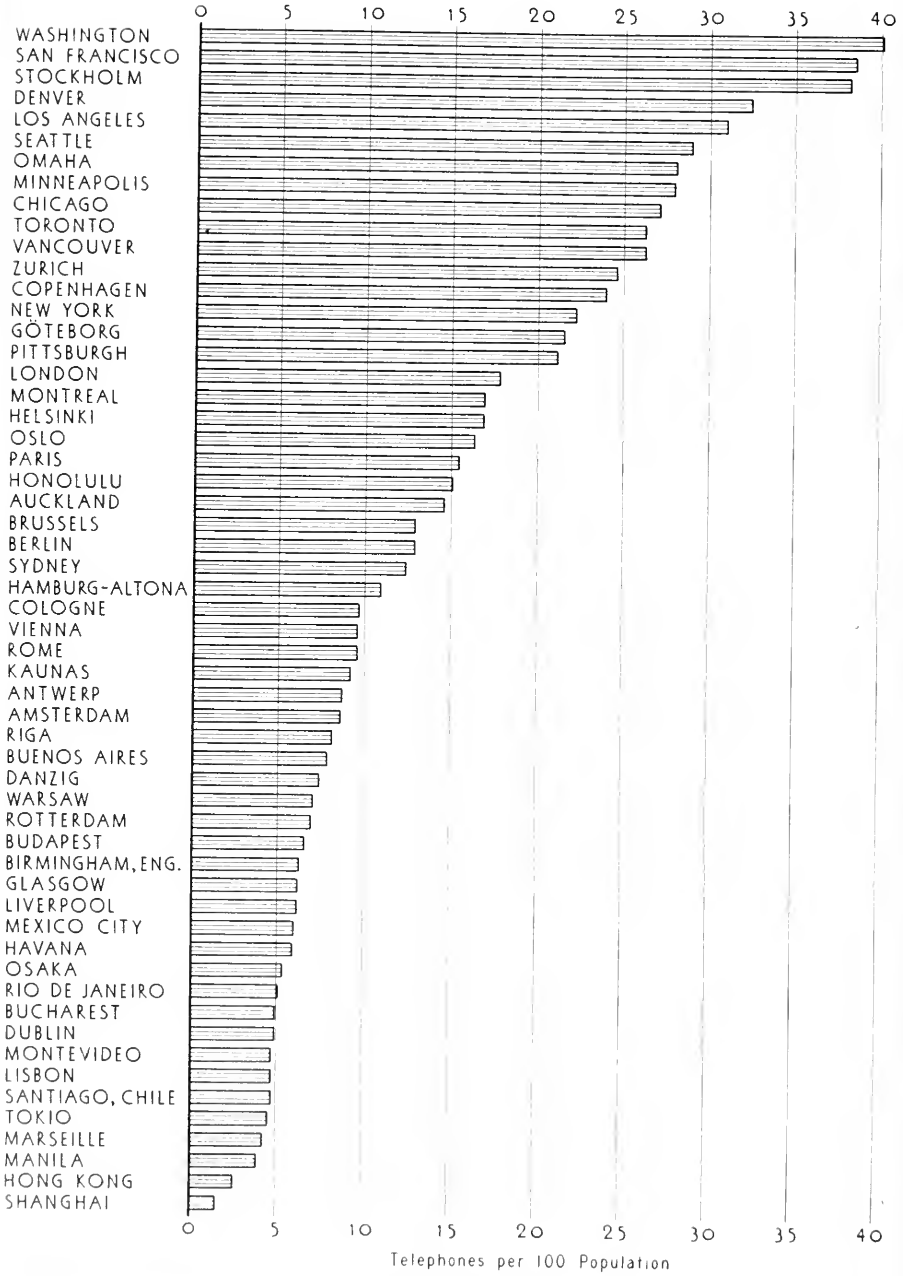
Ireland (Eire)†	43,086	—	43,086	.11%	1.47
Italy	—	611,254	611,254	1.49%	1.41
Latvia†	83,650	—	83,650	.20%	4.20
Lithuania	26,591	—	26,591	.06%	1.03
Netherlands	433.927	—	433,927	1.06%	4.97
Norway*	143,642	91,622	235,264	.57%	8.03
Poland	160,251†	134,577	294,828	.72%	0.84
Portugal	18,158	51,098	69,256	.17%	0.91
Roumania	—	93,314	93,314	.23%	0.47
Russia¶	1,272,500	—	1,272,500	3.10%	0.75
Spain	—	300,000	300,000	.73%	1.19
Sweden	801,562	1,666	803,228	1.95%	12.73
Switzerland	450,380	—	450,380	1.10%	10.72
Yugoslavia	67,588	—	67,588	.16%	0.43
Other Places in Europe	275,482	—	275,482	.67%	1.66
Total	13,375,412	1,930,047	15,305,459	37.25%	2.67
ASIA:					
British India†	31,878	51,500	83,378	.20%	0.02
China	40,000	120,000	160,000	.39%	0.04
Japan†	1,367,958	—	1,367,958	3.33%	1.89
Other Places in Asia	198,462	103,295	301,757	.73%	0.15
Total	1,638,298	274,795	1,913,093	4.65%	0.18
AFRICA:					
Egypt	64,823	—	64,823	.16%	0.29
Union of South Africa†	205,892	—	205,892	.50%	2.03
Other Places in Africa	133,508	1,350	134,858	.33%	0.11
Total	404,223	1,350	405,573	.99%	0.26
OCEANIA:					
Australia*	630,175	—	630,175	1.54%	9.14
Hawaii	—	33,287	33,287	.08%	8.10
Netherlands Indies	45,033	4,328	49,361	.12%	0.07
New Zealand†	206,216	—	206,216	.50%	12.69
Philippine Islands	1,263	28,579	29,842	.07%	0.19
Other Places in Oceania	4,935	330	5,265	.01%	0.24
Total	887,622	66,524	954,146	2.32%	0.99
TOTAL WORLD	16,588,358	24,501,989	41,090,347§	100.00%	1.91

* June 30, 1938. † March 31, 1939. ¶ U.S.S.R., including Siberia and Associated Republics.

§ Includes approximately 21,900,000 automatic or "Dial" telephones, of which about 42% are in the United States.

TELEPHONES PER 100 POPULATION OF LARGE CITIES

January 1, 1939

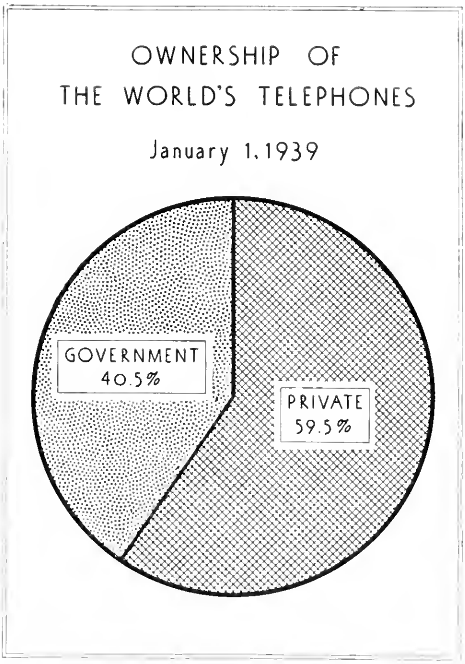


in the government operated systems, while telephone traffic amounted to 175 and 35 annual messages per capita, respectively.

United States cities continue in the lead among all the cities in the world, as far as telephone facilities are concerned, both in actual number and in relation to population. New York City, with an estimated population of 7,333,000 at the beginning of 1939, had 1,632,348 telephones,—more than any other city in the world and, in fact, more telephones than in all of France. Greater London is about 30 per cent more populous than New York City, but New York City had 38 per cent more telephones. The central part of London, with only a little over 4,000,000 people, had 717,468 telephones, whereas Chicago, with a population of 3,550,000, had 962,351 telephones, or 27.11 per 100 inhabitants, compared with 17.81 in central London.

Berlin's population of 4,339,000 was served by 599,911 telephones, or only 13.83 per 100 population. Paris, with a population of 2,830,000, had 437,139 telephones, or 15.45 telephones per 100 inhabitants. More than 100 large cities in this country had a telephone development superior to that of any one of these three European capitals.

The world's leading cities, in point of relative telephone development, are to be found in the United States. Among large cities, Washington, D. C., ranked first, with 40.14 telephones per 100 population, and San Francisco second, with 38.53 telephones per 100 population. Outstanding among foreign cities in this respect was Stockholm, Sweden, with 32.64 telephones per 100 inhabitants within its telephone exchange area, and 38.28 in the city of Stockholm proper.



Not only is the telephone development of foreign countries everywhere below that of the United States, but elsewhere a greater proportion of the telephone facilities is frequently concentrated within the large metropolitan centers. Thus, one-third of all French telephones are in metropolitan Paris, more than a third of all those in Great Britain are in Greater London, more than a fourth of those in Sweden are in Greater Stockholm, etc. In this country, only about 8 per cent of all telephones are in New York City and less than 5 per cent in Chicago. The corollary of this situation is that the telephone facilities of those foreign communities which are less densely populated appear, in most

TELEPHONE DEVELOPMENT OF LARGE CITIES, JANUARY 1, 1939

Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones Per 100 Population
ARGENTINA:			
Buenos Aires	3,200,000	252,400	7.89
AUSTRALIA:			
Adelaide	321,000	35,935	11.19
Brisbane	326,000	35,805	10.98
Melbourne	1,036,000	135,518	13.08
Sydney	1,289,000	159,825	12.40
BELGIUM:#			
Antwerp	560,000	48,696	8.70
Brussels	991,000	127,639	12.88
Liege	433,000	29,885	6.90
BRAZIL:			
Rio de Janeiro	1,900,000	95,603	5.03
CANADA:			
Montreal	1,079,000	183,103	16.97
Ottawa	198,200	39,227	19.79
Toronto	803,300	211,601	26.34
Vancouver	286,100	75,354	26.34
CHILE:			
Santiago	850,000	40,109	4.72
CHINA:			
Hong Kong	800,000	20,322	2.54
Shanghai††	4,000,000	63,355	1.58
CUBA:			
Havana	724,000	42,937	5.93
DANZIG:			
Free City of Danzig	253,000	18,792	7.43
DENMARK:			
Copenhagen	883,000	211,156	23.91
FINLAND:			
Helsinki	305,000	51,328	16.83
FRANCE:			
Bordeaux	260,000	23,311	8.97
Lille	200,000	18,566	9.28
ITALY:			
Bologna	315,000	14,738	4.68
Milan	1,206,000	109,168	9.05
Naples	920,000	31,373	3.41
Rome	1,280,000	122,442	9.57
Venice	284,000	10,209	3.59
JAPAN:†			
Kobe	989,000	46,265	4.68
Kyoto	1,160,000	51,457	4.44
Nagoya	1,224,000	46,122	3.77
Osaka	3,321,000	176,697	5.32
Tokio	6,458,000	290,510	4.50
LATVIA:†			
Riga	391,000	31,795	8.13
LITHUANIA:			
Kaunas	110,000	10,124	9.20
MEXICO:			
Mexico City	1,447,000	86,088	5.95
NETHERLANDS:			
Amsterdam	794,000	67,927	8.56
Haarlem	174,000	14,474	8.32
Rotterdam	635,000	44,145	6.95
The Hague	540,000	57,635	10.67
NEW ZEALAND:†			
Auckland	213,000	31,077	14.59
NORWAY:*			
Oslo	411,000	67,180	16.35
PHILIPPINE ISLANDS:			
Manila	620,000	24,035	3.88
POLAND:			
Lodz	670,000	19,048	2.84
Warsaw	1,270,000	90,627	7.03
PORTUGAL:			
Lisbon	697,000	32,988	4.73

Lyon	650,000	39,369	6.06
Marseille	915,000	38,801	4.24
Paris	2,830,000	437,139	15.45
GERMANY:†			
Berlin	4,339,000	599,911	13.83
Breslau	623,000	48,203	7.74
Cologne	771,000	75,393	9.78
Dresden	821,000	75,569	9.21
Dortmund	585,000	28,945	4.95
Essen	672,000	36,743	5.47
Frankfort-on-Main	647,000	68,112	10.52
Hamburg-Altona	1,724,000	188,861	10.96
Leipzig	767,000	73,959	9.64
Munich	866,000	97,215	11.23
Vienna	1,874,000	180,165	9.61
GREAT BRITAIN AND NO. IRELAND:†			
Belfast	415,000	23,336	5.62
Birmingham	1,259,000	79,847	6.34
Bristol	450,000	31,376	6.97
Edinburgh	465,000	47,066	10.12
Glasgow	1,150,000	72,359	6.29
Hull	359,000	25,134	7.00
Leeds	568,000	36,825	6.48
Liverpool	1,265,000	79,228	6.26
London—(City and County of London)	4,028,000	717,468	17.81
Manchester	1,015,000	68,191	6.72
Newcastle	482,000	28,167	5.84
Sheffield	522,000	28,776	5.51
HAWAII:			
Honolulu	153,000	22,994	15.03
HUNGARY:			
Budapest	1,635,000	107,906	6.60
Szeged	141,000	2,635	1.87
IRELAND (Eire):†			
Dublin	482,000	23,928	4.96
ROUMANIA:			
Bucharest	900,000	44,617	4.96
SWEDEN:			
Göteborg	276,000	59,353	21.52
Malmö	151,000	27,971	18.49
Stockholm	460,000	176,168	38.28
SWITZERLAND:			
Basel	155,000	38,191	24.64
Bern	116,000	30,174	26.01
Geneva	151,000	30,850	20.43
Zurich	287,000	70,573	24.59
URUGUAY:			
Montevideo	705,000	33,447	4.74
UNITED STATES: (See Note)			
New York	7,333,000	1,632,348	22.26
Chicago	3,550,000	962,351	27.11
Los Angeles	1,415,000	439,258	31.04
Pittsburgh	1,047,000	222,063	21.21
Total 7 cities over 1,000,000 Population	18,477,200	4,263,891	23.08
Milwaukee	798,000	157,437	19.73
San Francisco	732,000	282,008	38.53
Washington	597,000	239,668	40.14
Minneapolis	521,600	145,900	27.97
Total 13 cities with 500,000 to 1,000,000 Population	8,638,300	2,105,983	24.38
Seattle	427,500	123,752	28.94
Denver	321,000	104,156	32.44
Hartford	245,500	64,479	26.26
Omaha	237,800	66,762	28.08
Total 28 cities with 200,000 to 500,000 Population	8,921,500	1,872,574	20.99
Total 48 cities with more than 200,000 Population	36,037,000	8,242,448	22.87

NOTE: There are shown, for purposes of comparison with cities in other countries, the total development of all cities in the United States in certain population groups, and the development of certain representative cities within each of such groups.

* June 30, 1938. # February 28, 1938. † March 31, 1939. †† International Settlement and French Concession.

TELEPHONE DEVELOPMENT OF LARGE AND SMALL COMMUNITIES, JANUARY 1, 1939

Country	Service Operated By (See Note)	Number of Telephones		Telephones Per 100 Population	
		In Communities of 50,000 Population and Over	In Communities of less than 50,000 Population	In Communities of 50,000 Population and Over	In Communities of less than 50,000 Population
Australia*	G.	390,700	239,475	11.66	6.76
Belgium#	G.	278,411	115,117	7.70	2.42
Canada	P.G.	751,273	608,144	20.03	8.15
Denmark	P.	237,617	205,381	21.27	7.61
Finland	P.	70,532	114,924	13.31	3.44
France	G.	866,080	723,515	8.17	2.31
Germany†	G.	2,711,165	1,435,324	8.50	3.00
Great Britain and No. Ireland†	G.	2,322,000	950,000	8.42	4.73
Hungary	G.	123,384	41,978	5.10	0.55
Japan†	G.	959,734	408,224	3.97	0.85
Netherlands	G.	273,747	160,180	7.37	3.20
New Zealand†	G.	88,079	118,137	15.24	11.28
Norway*	P.G.	97,781	137,483	17.18	5.82
Poland	P.G.	189,681	105,147	4.11	0.35
Sweden	G.	336,737	466,491	26.81	9.23
Switzerland	G.	218,620	231,760	22.70	7.16
Union of South Africa†	G.	128,133	77,759	8.69	0.90
United States	P.	11,150,933	8,802,330	21.71	11.22

NOTE: P. indicates that the telephone service is wholly or predominantly operated by private companies, G. wholly or predominantly by the Government, and P.G. by both private companies and the Government. See first table.

* June 30, 1938. # February 28, 1938. † March 31, 1939.

cases, extremely inadequate when compared with American standards. Typical development statistics for European communities with a population of less than 50,000 were 2.31 telephones per 100 population in France, 3.00 in Germany, 4.73 in Great Britain. Canada, Switzerland and the Scandinavian countries had a somewhat better telephone development in the smaller communities than did the large European countries. In similar communities in the United States there were 11.22 telephones for every 100 people—a better telephone development than that to be found in any large city in Asia, Africa or South America and in all but a very few capitals in Europe.

During 1938, nearly 29 billion local and long distance telephone calls were completed in the United States, equivalent to some 223 messages for every man, woman and child in the country or to 1,469 calls per average telephone in service during the year. The average per capita telephone use in the world outside the United States was only 16 calls during that year.

The telephone facilities at the disposal of the American public are far more extensive than those found abroad. In this country a greater proportion of the population in each community, whether large or small, has ready access to a telephone; a greater and more complete network of long distance wires and cables provides rapid and dependable voice communication from city to city; and overseas radiotelephone circuits bring nearly every important point in the civilized world within reach of the American telephone.

FOR THE RECORD

A. T. & T. VICE PRESIDENTS IN NATIONAL DEFENSE POSTS

Two Vice Presidents of the American Telephone and Telegraph Company, Frank B. Jewett and William H. Harrison, have been appointed to important posts in connection with the country's program of national defense. Dr. Jewett, who is also President of the Bell Telephone Laboratories, is serving as a member of the National Defense Research Committee. Mr. Harrison, Vice President and Chief Engineer, has been made Director of the construction division of the production department of the National Defense Advisory Commission, and is now on leave of absence from the telephone business.

The National Defense Research Committee, of which Dr. Jewett has been appointed a member, is empowered to correlate and support scientific research on the mechanisms and devices of warfare, to aid and supplement the experimental and research activities of the Army and Navy, and to conduct research for the creation and improvement of instrumentalities, methods, and materials of war.

Chairman of the committee is Dr. Vannevar Bush, President of the Carnegie Institution. Other members are Dr. James B. Conant, President of Harvard University; Dr. Karl T. Compton, President of Massachusetts Institute of Technology; Dr. Richard C. Tolman, of the California Institute of Technology; Conway P. Coe, U. S. Commissioner of Patents; Rear Admiral H. G. Bowen, of the Navy; and Brigadier General G. V. Strong, of the Army.

An initial division of the work of the committee has been made in five major groups under the supervision of the members, as follows: Armor and ordnance, Dr. Tolman, chairman; Bombs, fuels, gases, chemical problems, Dr. Conant, chairman; Communication and transportation, Dr. Jewett, chairman; Detection, controls, instruments, Dr. Compton, chairman; Patents and inventions, Commissioner Coe, chairman.

William S. Knudsen, who is in charge of correlating production under the national defense program, pointed out in announcing Mr. Harrison's appointment that he has had general direction of vast construction activities reaching into every state in the Union, thereby gaining a unique knowledge of the architectural and engineering professions and the building construction industry throughout the country. The appointment of Mr. Harrison conforms with Mr. Knudsen's policy of not selecting men from a particular industry to handle the responsibilities pertaining to their own business or profession, but rather men outside the industry who have had a broad experience with its problems, its personnel, and its facilities.

DIRECTORS ARE RE-ELECTED AT ANNUAL MEETING

At the annual meeting of the American Telephone and Telegraph Company, held at 195 Broadway, New York City, on April 17, the Directors were re-elected. About 400 persons attended the meeting, and the total number of shares voted was

11,069,110. This represents 59.2 per cent of the outstanding stock; 52.9 of the stockholders voted by proxy or in person.

President Walter S. Gifford presided. In referring to the reduction of $5,300,000 in long distance rates which was to become effective on May 1, Mr. Gifford said:

"In some of the publicity following the announcement of this rate reduction, and occasionally from other sources, I get the impression that there are a few who believe that somehow we gain enough new business through these long distance rate reductions and secure sufficient mass production economies to leave the Company with substantially as good net earnings after the reduction as before. Some even suggest the net earnings will be more. I should like to take a few minutes of your time to give you the facts.

"Let us consider the new or additional business part of this conclusion first. If we make a rate reduction which amounts to, say, 20 per cent of our long distance gross revenue, it is a matter of arithmetic that we must secure in new business the equivalent of 25 per cent of our remaining revenue if we are to come out with the same total dollars of revenue with which we started. Even then, of course, as I will discuss in a moment, the Company would be far from having the same net earnings, since the 25 per cent increase in revenue could only come from an increased number of calls and each new call requires operators, switchboards, circuits, and men to maintain the facilities; that is, requires added expense. Still more than 25 per cent new business would be necessary, therefore, before the Company's former dollars of net earnings could be realized, and of course, if added plant investment were required to care for the increase in business, even more than the former net earnings would be needed to earn a return on this additional investment. The fact is that there is no basis in experience for the conclusion that anything like these amounts of new business are secured from a given reduction in long distance telephone rates.

"Secondly, our long distance business has different characteristics from those businesses to which the principle of mass production economies is applicable. Every long distance call which we handle is a separate and individual transaction. There must be operators available at each terminal to handle these calls, and, if it is a switched call, other operators at intermediate points. There must be switchboard capacity at each terminal, and sometimes at intermediate points. A substantial portion of the expense on long distance calls relates directly to this expense of handling the call, and the very nature of the business makes it impossible to get mass production economies as to this part of the expense.

"You may well ask then, 'How is it possible that we have made so many rate reductions over the last fourteen years?' or, stated another way, 'How have we obtained the necessary economies in over-all operation so as to make these many reductions possible?' The fact is that such economies have come about through two major contributions within the business. One is the continued development of cheaper and more efficient telephone plant, including transmission systems by which a large number of telephone channels can be provided over a single circuit; and the other is through improvements in administration and the operating job itself.

"The general thesis that we get all or even a large part of our money back from rate reductions through new business and mass production savings in expense is unsound. It has not been our experience, and we have had considerable experience with rate reductions over the years. Your management is satisfied that we recover through these sources only a small part of our loss; that for the long pull we must, as in the past, continue to depend upon research and upon improvement in operations for reductions in costs; and that, in the long run, reductions in rates can be made only if and as such reductions in costs are realized. We shall continue our efforts along these lines to make telephone service more economical for the user."

CONTRIBUTORS TO THIS ISSUE

Following graduation from the University of Delaware with a B.S. degree, in 1911, Charles J. Schaefer, Jr. was engaged in hydrographic and construction engineering for three years, when he entered the Bell System in the Traffic Department of The Bell Telephone Company of Pennsylvania at Philadelphia. Prior to his entering the military service as a regular army officer in 1917, he was an engineer on toll rates and toll engineering. Following the World War he resigned his commission as Captain of Artillery and returned to the Bell of Pennsylvania in the Personnel and Public Relations Department. In 1925 he was transferred to the American Telephone and Telegraph Company, where he is now Secretary of the Employees' Benefit Committee and Staff Assistant in the Personnel Relations Department. In addition to his participation in the development and administration of benefit, pension, and related activities, he has been Secretary of the Trustees of the Theodore N. Vail Memorial Fund and of the National Committee of Award for a number of years, and in this capacity has been especially interested in the recognition of outstanding public service as exemplified by the Vail Medal awards. He is the author of "The 'Plan for Employees' Pensions, Disability Benefits and Death Benefits' Completes Twenty-five Years of Service," which appeared in the Quarterly for January, 1938.

Having majored in Journalism, Clarence S. Bolen was graduated by Ohio University, at Athens, O., in 1926 with the B.A. degree. After three years of newspaper work he joined the Public Relations Department of the Southern Bell Telephone and Telegraph Company at Atlanta in 1929. He became Editor of *The Southern Telephone News* in 1939. The photographs as well as the article about the recent Third Army maneuvers are the result of his pursuit of the Red and Blue armies through several states.

After graduation from the University of Pennsylvania with the B.A. degree in 1910, Peter L. Schauble taught for three years. In 1913 he entered the Commercial Department of the Bell Telephone Company of Pennsylvania at Erie, and later served as local manager at Warren and at Erie. In 1919 he was transferred to the Public Relations Department in Philadelphia, was made Advertising Supervisor in 1922, and in 1927 became General Information Manager. As head of the Company's Public Relations Department, he was deeply interested in the part which communications played in the national convention to which Philadelphia played host last June.

Shortly before receiving the degree of B.E. from the University of Iowa in 1917, Glen Ireland entered the Army, serving for about two years as a signal officer in the Field Artillery. In 1919 he was employed by the Northwestern Bell Telephone Company (then the Iowa Telephone Company) on construction work. He was later transferred to the Engineering Department at Des Moines, where he became Division Transmission

Engineer. In 1923 he was transferred to the American Telephone and Telegraph Company in New York. There, in the Department of Operation and Engineering, he worked on toll transmission problems and later on equipment maintenance matters. He was appointed Transmission Engineer of the A. T. & T. Co. in 1939. Included in his interests, therefore, are matters which may affect telephone transmission—as did the magnetic disturbances of last March.

RECEIVING the B.A. degree from Lafayette College in 1907, and the LL.B. degree from New York Law School in 1909, **ROBERTSON T. BARRETT** practiced law until 1918, and for the next three years was engaged in newspaper work. In 1921 he joined the Information Department of the A. T. & T. Company, and since 1936 he has combined his duties in that department with those of Historical Librarian of the A. T. & T. Co. He is editor of the *Telephone Almanac,* and has contributed a number of articles to the QUARTERLY, the most recent being "The Telephone as a Social Force" in the issue for April, 1940.

BORN in Denmark, **KNUD FICK** was graduated in 1916 from Hellerup Gymnasium, near Copenhagen, with a degree corresponding to Bachelor of Arts, supplementing this two years later with the degree of Candidate of Philosophy from the University of Copenhagen. Following a number of years in the Foreign Office and other branches of the Danish Government, he joined the American Telephone and Telegraph Company in 1925. In the Chief Statistician's Division of the Comptroller's Department he has been in charge of statistics and economics relating to foreign telephone development. In 1932 he was sent to Madrid, Spain, and in 1938 to Cairo, Egypt, in connection with work for the International Telecommunication Conferences. His present discussion of what statistical analysis reveals about the world telephone situation —as of a year and a half ago—is his sixth annual contribution to the QUARTERLY on this topic.

BELL TELEPHONE QUARTERLY

VOL. XIX OCTOBER, 1940 NO. 4

AMERICAN TELEPHONE & TELEGRAPH CO. • NEW YORK

OUR PART IN NATIONAL DEFENSE

The Bell System is a nation-wide telephone system — ready to serve the United States in normal times or emergency. It has . .

Walter S. Gifford, President, American Telephone and Telegraph Company

1. The trained forces to operate telephone equipment and plant.
2. The trained staffs to direct these operations.
3. The latest motorized, mechanized telephone groups of great mobility which can concentrate anywhere quickly.
4. A dependable service of supply that reaches anywhere in the United States.
5. [illegible]
6. [illegible]
7. The financial strength to keep going and work ahead for the future.

⁂

Each is important. All are necessary for good telephone service from day to day and for the needs of national defense.

It is the organization, the team-work, that counts. That means trained, experienced men and management working together [illegible] at the right material [illegible] will be at the right place at the right time.

Walter S. Gifford

The Bell System [illegible] part in the Nation's program of National Defense

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This [illegible] advertisement is current in national magazines during October

BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

VOL. XIX OCTOBER, 1940 NO. 4

Published in January, April, July and October for the
Bell System by the Information Department of the
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195 Broadway, New York, N. Y.

THE BELL SYSTEM'S PART IN NATIONAL DEFENSE

A Statement Broadcast over a Nation-wide Radio Network on October 14, 1940

By WALTER S. GIFFORD

President, American Telephone and Telegraph Company

In these critical times, national defense is the concern of all of us. Communications are an essential part of our national defense and I am happy to report to you that telephone facilities in America are by far the most comprehensive and the best in the world. In fact, surveying American industry as a whole, it is encouraging to realize — notwithstanding views to the contrary — that there is greater efficiency under American democracy than under any other form of government.

Your telephone service is the result of initiative and ability, fostered and given free rein in an enterprise privately owned and privately managed. And today we of the Bell System—and there are more than 300,000 of us—are ready to do our full part in the national defense program. Our business is financially sound. We have the best telephone equipment in the world and we have plenty of it. It has been provided out of the voluntary savings of many hundreds of thousands of men and women. We have a great scientific laboratory, which constantly strives to improve the communication art in which we have always been the leader. Our Western Electric Company, manufacturer of telephone equipment for over sixty years, is our service of supply, with stocks of apparatus and materials in warehouses strategically located throughout the nation. The Laboratories and the Western Electric, with their scientific and manufacturing experience, are coöperating with the Army and the Navy and the air forces, and are helpful in supplying some of their important needs and in solving some of their important problems. Our telephone construction and maintenance crews are fully mechanized and can be concentrated anywhere quickly. Above all, trained and experienced men and women and the management work together in full coöperation, and we are accustomed to plan ahead so that the right material and the right skill will be at the right place at the right time.

It is a real satisfaction to all of us in the Bell System, and I feel sure it is to you, to know that we can contribute much to the success of our country's national defense — a success which will demonstrate anew the efficiency of American democracy.

NEW ENGLAND WINTER

This scene of ice-festooned telephone wires is Fig. 1 of the article which begins on the opposite page

OUTWITTING OPEN WIRE'S WORST FOE

Study of Areas Where Ice Storms Are Likely to Occur, Building to Withstand Expected Loads, Substitution of Cable as Economics Permit, Increase the Reliability of Outside Plant

By RAYMOND C. SILVERS

The beauty of an ice-sheathed countryside glistening in the sun has long been a source of poetic inspiration. Countless schoolboys have declaimed from James Russell Lowell's "The Vision of Sir Launfal" that, "No mortal builder's most rare device could match this winter palace of ice." In fact, the sight of trees and bushes and blades of grass encased in brilliant icy armor is a cherished picture to nearly everyone.

But not to the telephone man. To him an ice storm means trouble.

To provide a service free from interruption is the constant aim of the telephone Plant design, construction, and maintenance forces. Wind and storm and flood—the elements—are among their strongest opponents. Tornado, fire, ice, torrential rains—one or more of these may strike anywhere and leave wreckage in its trail. Each year, however, the Bell System is building up greater resistance to them and thereby is continually increasing the reliability of its service. Research work in the Bell Telephone Laboratories leads to new materials and apparatus which make for this end. Stronger materials, closer manufacturing controls, new maintenance methods, the extension of the cable network—all these measures combine to make the outside plant more nearly invulnerable and bring it closer to that elusive goal of day-in and day-out uninterrupted service.

Through the years, in fact from its very beginnings, the Bell System has striven to build lines which would withstand the compelling grip of ice wherever ice storms might be expected; to build lines which would give service when ice has brought highway traffic to a standstill, immobilized whole communities, and put a special value on telephone communication. Each year sees telephone service more nearly proof against the sudden onslaught of these storms. The degree of success in this long-drawn battle against ice and its ally, wind, has been far greater than the casual observer may realize. Failures occur, yes; but it must be remembered that it is the failures which make victories go unsung.

Some of the problems that are met and some of the measures which have

Fig. 2. IN WISCONSIN

brought about this greater dependability of Bell System service under winter conditions are discussed in this article.

When Ice Forms

As far as telephone plant is concerned, damage from ice is most likely to occur as a result of its formation about aerial wires during a rainfall when temperatures are either at or just below freezing. Less frequently, wet snow will accumulate in considerable amount on wires and poles; and in other cases atmospheric conditions may produce deposits of frost. In some parts of the Pacific Northwest, where occur what are locally known as "silver thaws," heavy encasements of rime have accumulated on wires to the thickness of several inches. Examples of accumulations of ice on wires and trees are shown in the accompanying photographs. Figure 1 (page 230) is a scene in New England; Figure 2 shows the ice covered wires of a line in Wisconsin; and the picture in Figure 3, taken in northern California, is an illustration of the extent to which insulators and crossarms become loaded and festooned with snow. Figure 4 is a photograph of ice and frost on a rural telephone line not far from Seattle. Measurements at this point showed the wire to be encased with ice to a diameter of ½-inch with a frost deposit overlaying the ice—the total diameter of wire, ice, and frost being 7 inches.

In 1911 Theodore N. Vail, then President of the American Telephone and Telegraph Company, wrote to J. J. Carty, the chief engineer, "I would like to have you prepare a map of the United States showing the extent and range of each sleet storm that we have had in this country which has affected the wires, going back as far as there are any particular records,

FIG. 3. IN THE MOUNTAINS OF NORTHERN CALIFORNIA

and far enough if possible to see whether any particular section of the country is more liable to these destructive sleet storms than others—the object being, if there are sections in the country where these storms are more liable to occur than others, that we can lay out our underground con-

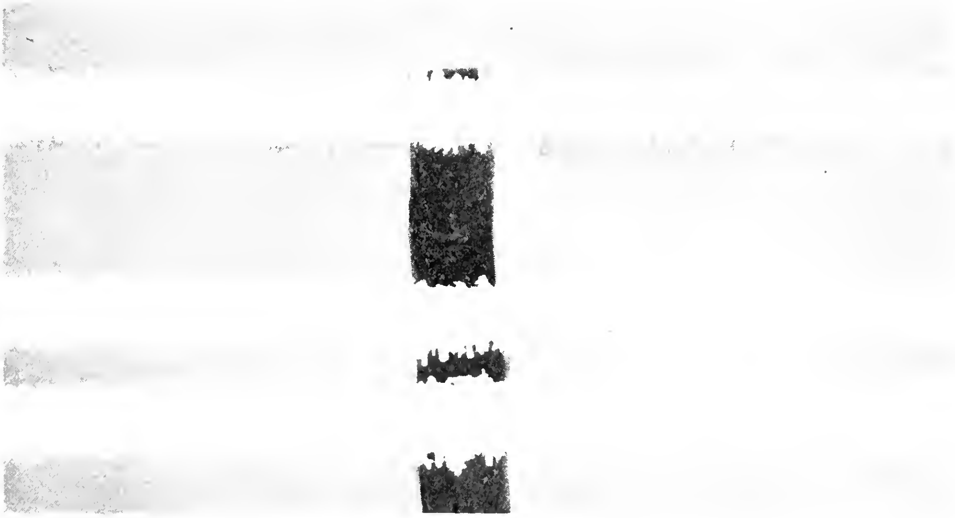

FIG. 4. ICE AND FROST

The total diameter of these encrusted telephone wires is seven inches

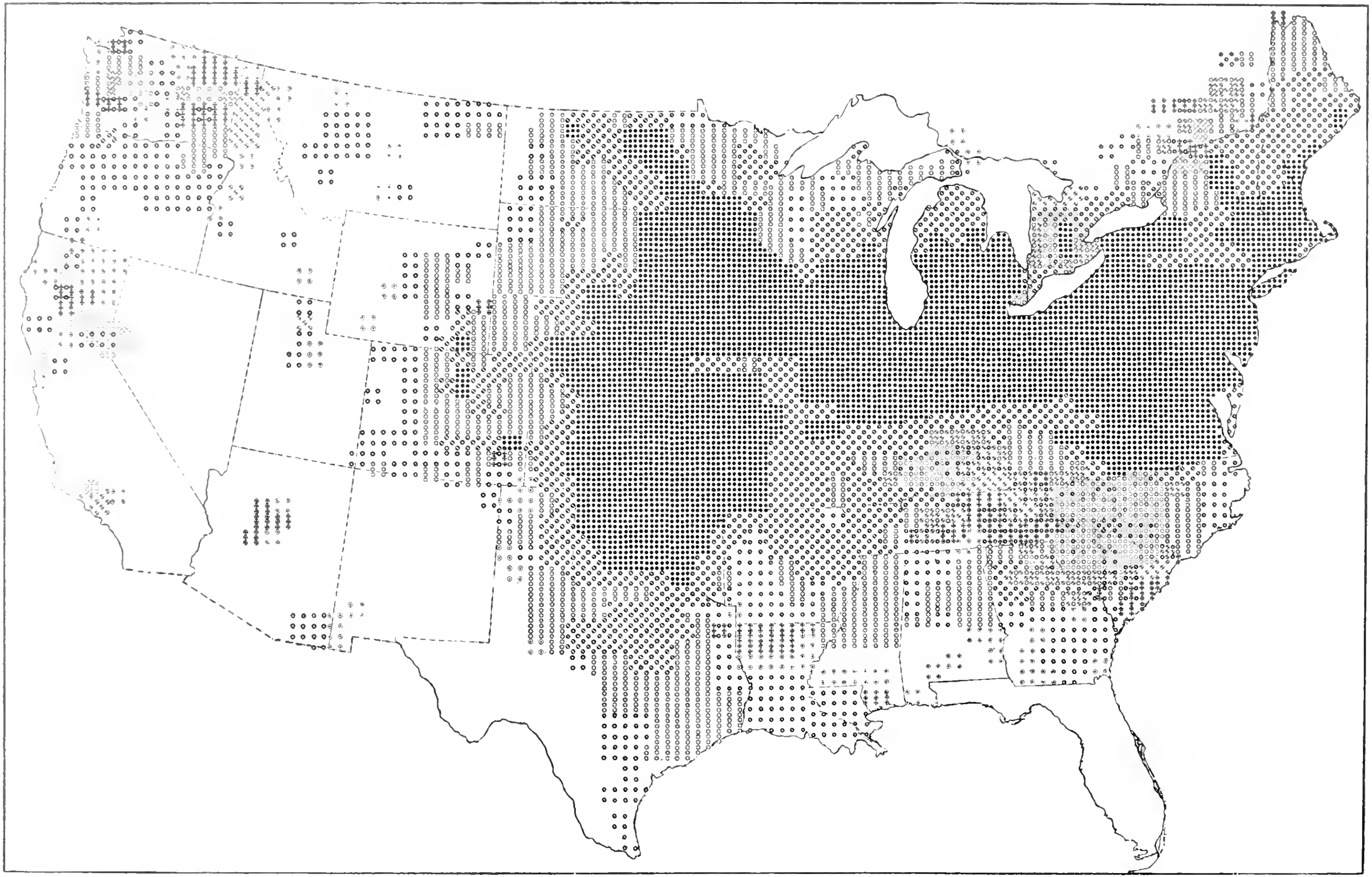

Fig. 5. ICE-STORM MAP

Pins with vari-coded heads record the incidence of ice storms in the United States during a period of more than a quarter-century. For the story which the different codes tell, refer to the opposite page struction in such a way as to cover these sections first." After collecting all available information on ice storms affecting the Bell System plant prior to that time, the map was prepared for Mr. Vail.

This marked the start of the systematic compilation of detailed records of ice storm damage to System lines, including comprehensive data with regard to the severity of ice storms, their frequency and distribution, as the basis for intelligent design of the pole line and wire plant. From that time on, as storm data became available, they were posted, using coded-head pins, on a large wall map of which Figure 5 is a reproduction. This ice storm map covered the United States and that portion of Canada in which the Bell Telephone Company of Canada operates. The various Companies in the System continued to prepare these careful reports, which in turn were posted on the map until it represented the history of 25 years of experience with ice on wires of the Bell System.

For the purpose of the map, ice storms were divided into two classes from the standpoint of intensity: heavy and medium. When the diameter of the ice-covered wires in any storm was ¾-inch or greater, or when the damage was commensurate with a storm of this intensity, the storm was designated as "heavy." When the diameter in a given storm was less than ¾-inch but sufficient to cause appreciable damage to the aerial plant, it was regarded as "medium." It should be noted at this point that the above classifications of storms as "heavy" or "medium," made for the purpose of measuring storm severity and frequency, are not the same as the definitions of heavy and medium storm loading which were subsequently adopted in the National Electrical Safety Code, as discussed later in this article.

AREAS on the map (Figure 5) in which "heavy" ice storms were recorded are marked with pins with heads having a black background. The pin head code for showing the frequency of occurrence of such heavy storms is indicated at the bottom of this page. Areas in which medium ice storms only were experienced are designated by pins having a white background with black markings, the same general type of code as in the case of heavy storms being employed but using black instead of white lines, crosses and dots to indicate frequency of occurrence.

PIN HEAD CODE FOR HEAVY STORMS

See map on opposite page

Average Occurrence of Heavy Storms	Coded
At least once in 3 years	Solid black
Once in every 3–6 years	Black with white stripe
Less than once in 6 years	Black with white cross
Only one heavy ice storm	Black with white spot

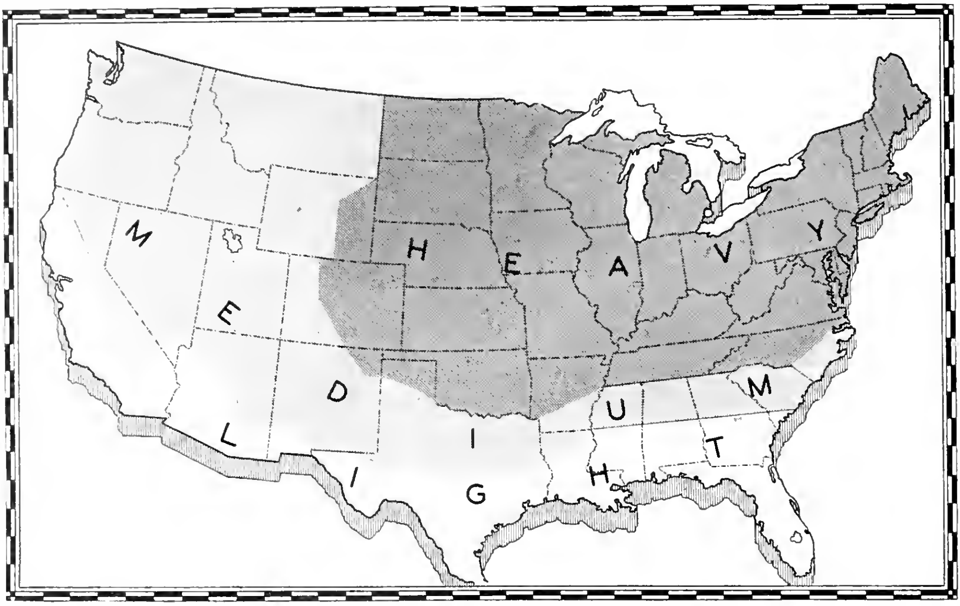

FIG. 6. N.E.S.C. STORM LOADING MAP

Since 1926 this has served as a guide to the wire-using companies

Again, to keep clear the distinction between storm loading and storm damage, this map indicates only the intensity and frequency of occurrence of storm loads. As indicated later, in the design and maintenance of the telephone plant the strength of construction and use of the more storm proof types of plant are varied to meet the storm loads which experience shows may be imposed. A map such as that shown in Figure 5 serves its main purpose when it shows which areas should be fortified against damage and service disruption.

IN those areas where heavy storms predominated, the occurrence of medium storms has not been indicated. However, in sections where most storms were "medium," but in which some heavy storms occurred, pins with black background and pins with white background are to be seen intermingled.

The method adopted in posting the map results in a closer spacing of the pins in those areas in which ice storms are more prevalent. In those areas where the telephone plant was not operated by companies associated in the Bell System, in which no open-wire telephone plant existed, or in which no ice storms were reported, no pins were placed. It is interesting to observe over what an extensive portion of the United States at least one ice storm was experienced during the period of the study.

Data such as this map provided were not available from any of the regular sources of meteorological information, and were needed to put on a more exact and economically sound

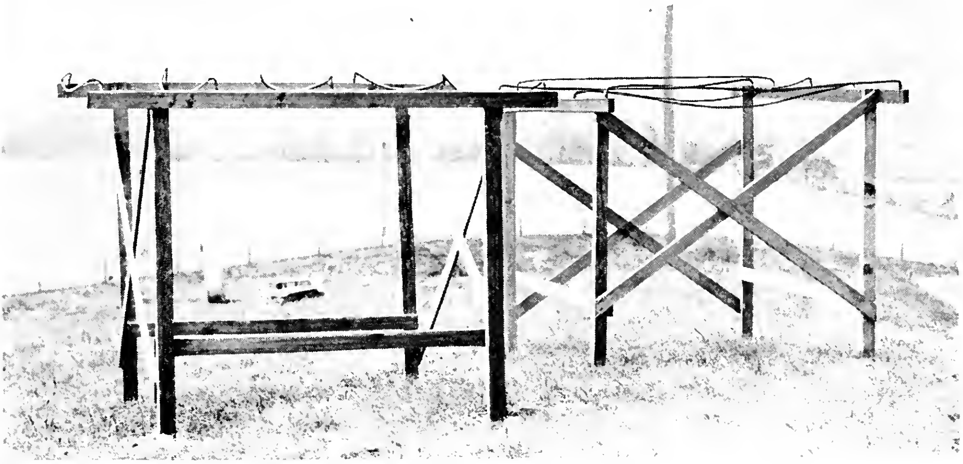

FIG. 7. ICE CATCHERS

These racks of various sizes of wire, located at different points throughout the country, add to the information about accumulations of ice

basis the determination of the type of telephone line adequate for a given locality. The importance of delineating these ice storm zones is evident when we consider that the cost of, say, a typical 30-foot 40-wire pole line constructed to meet conditions to be expected in areas where heavy ice storms occur frequently would be one third again as much as would that of a similar line where such storms do not occur.

The N.E.S.C. Code

IN the National Electrical Safety Code, drawn up under the procedure of the American Standards Association by a sectional committee under the sponsorship of the National Bureau of Standards, the United States is divided into three different storm loading areas based on weather conditions, as shown in Figure 6. The establishment of these areas as a guide to the wire-using companies in their basic construction and maintenance practices has been an important contribution to the art of overhead line construction and has made for safety to employees and the public as well as being an aid in setting up standards to promote continuity of service. The data on ice storms compiled by the Bell System, previously referred to, have been helpful in this connection.

Since the issuance of the fourth edition of the Safety Code in 1926, additional data on ice and wind during storms have been accumulated by the electric light and power, railroad, telegraph, and telephone companies, all of which coöperate in the preparation of the Code. Data on wind velocities were, in the main, obtained from the United States Weather Bureau. In addition to collecting data on ice deposits on line wires and on the wind conditions accompanying ice accretions, racks carrying lengths of different sizes of wire were placed at various locations throughout the country as an aid in determining the magni-

Fig. 8. Substitute for Ice

Since it is not always winter at the Chester, N. J., field laboratory of the Bell Telephone Laboratories, bricks are here being hung on wires to test their strength

tude of ice accumulations. Figure 7 shows such racks installed in 1929 at the Chester, New Jersey, field laboratory of the Bell Telephone Laboratories. These are only two out of more than 100 located at various points throughout the country by a joint communications and railroad committee to study storm loading conditions, the work being done by the Association of American Railroads, Western Union Telegraph Company, Postal Telegraph Company, and Bell System coöperatively. Similar work was done under the auspices of the Edison Electric Institute, involving the installation of approximately 125 racks and associated equipment for taking observations on all formations on electrical supply line conductors.

In the light of additional storm data which have been collected, it appears that in the revision of the Code, which is now under way, some changes may be desirable in the general lines of demarcation between the areas and in the assumed wind velocities in these areas.

Ice Loads and Telephone Wires

Our early arithmetic taught us that the area of a circle is in proportion to the square of its radius. From this, it follows that the weight of ice accumulations on wires increases rapidly with the thickness of the coating. A sheath of ice of ¼ inch in radial thickness adds a load of only two ounces per foot of wire. A ½-inch coating, however, results in the addition of a weight of about six ounces per foot, and an accumulation of 1 inch in radial thickness amounts to about 22 ounces per foot. By simple arithmetic, the weight of a 1-inch coating of ice on a telephone wire in a 150-foot span would amount to about 200 pounds, or about 15 to 40 times the weight of the wire itself. This is evidence of the potentialities for damage through ice loads alone.

It must not be inferred that ice is necessarily deposited as uniform and symmetrical coatings. On the contrary, it may be said that, except in the case of light glazes, a uniform ice coating is found only infrequently. The fact that it ordinarily appears as a pendant deposit of non-circular section, and frequently in the form of icicles, is only one factor which has added to the difficulties of obtaining reliable and useful data on ice accumulations and appraising their effect. To place on a workable basis information obtained in the field on ice deposits, it has been the practice to equate it into terms of equivalent radial ice coatings.

In laboratory tests it is often necessary to simulate ice loads. Figure 8 shows a span of wire at the Chester field laboratory being loaded with bricks to test a new type of tie for securing the wire at the insulators.

It is not alone the weight of ice on a wire which makes for damage. Its presence also increases the sail area which the wire presents to the wind. The diameters of line wires commonly used in telephone work vary from about .080 inch to about .165 inch and it is readily evident that a ½-inch radial ice coating increases the area exposed to the wind by 700 to 1300 per cent. With a sufficiently strong wind transverse to the line, the wind pressure per foot of ice-covered wire may considerably exceed the weight of wire and ice combined. For this reason a heavy ice load acting together with a strong wind results in a particularly destructive combination.

Moderate ice loads alone have little mechanical effect on telephone wire. But fairly light glazes of ice when acted upon by wind of only medium intensity sometimes are responsible for a phenomenon known as dancing, which is now being given active study on wires and cables both in service and at the Bell Telephone Laboratories' testing ground at Chester. Dancing wires oscillate in a plane vertical to the wind. The dancing is sometimes of sufficient violence to short-circuit the wires; to cause mechanical damage at the insulators, due to chafing; or to produce breakage or weakening of the wire from the "fatigue" of the metal which results when the wires are bent back and forth while dancing. Some types of long distance carrier telephone circuits must be built with relatively close spacing between the two wires constituting each pair, and on such circuits the swinging of ice-glazed wires in the wind may result in the actual freezing together of the wires.

FIG. 9. CROSS-ARMS DOWN

The weight of the ice load on these wires has pulled the cross-arms from the pole

Heavy ice loads or combinations of ice and wind may result in either wire breaks due to the increased tensions developed or in permanent stretching of the wire. Increased sags due to permanent stretching not only reduce clearances between wire and ground but also increase the possibility that the wires may swing together in the wind during and also after the ice storm. A severe ice storm may therefore not only necessitate the replacement or repair of broken or damaged wire but may entail considerable work and expense for the readjustment and correction of wire sags.

ICE accumulations which may not be sufficient to cause mechanical damage may react adversely on the transmission efficiency of telephone circuits. At carrier frequencies they may greatly increase the attenuation losses during their presence on the wires. In combination with an accumulation of ice on crossarms, insulators, and at transposition points—where wires interchange positions in order to minimize interaction between circuits and improve circuit performance—these losses may reach a point where the circuits become temporarily inoperative.

On the most exacting types of long distance circuits, it is essential that uniformity of wire sags be maintained within close limits in order to avoid crosstalk. Permanent stretching of wire may take place in varying degrees under heavy storm loads, with the result that after the ice has melted there may be considerable differences in the sags between the two wires of a pair making up a telephone circuit. To prevent the tendency, under such conditions of unequal wire sag, for one telephone circuit to crosstalk over into another, it may be necessary following a storm to make a general readjustment of sags to meet the limits permissible for sag differences.

Effects of Ice and Wind Loads on the Pole Structure

WHILE wire is the chief sufferer, ice sometimes builds up to the point that the crossarms can no longer support the weight of the ice-covered wires. Then the arms either break or are stripped from the pole. Figure 9 is a photograph taken after a New England ice storm which tore the crossarms from their attachments to the pole. Crossarms and poles may also fail due to unbalanced loads on the pole structure resulting from breakage of the wire by excessive ice loads.

The most serious condition, however, from the standpoint of the pole plant, occurs where a strong wind transverse to the line either accompanies the formation of ice and snow deposits or follows a storm before the ice accumulation has had an opportunity to melt. A pole break due to such conditions is shown in Figure 10. It is fortunate, however, that while ice storms may occur fairly frequently and high winds still oftener, the chances of heavy ice and high wind occurring simultaneously are fairly remote.

To investigate the effects of wind on wires, considerable use is made of the wind tunnel, where conditions approximating those encountered in actual practice can be produced at will. Tests made both in the wind tunnel and under natural conditions have demonstrated the interesting fact that

FIG. 10. POLE DOWN

This pole has succumbed to the combined forces of ice-weight and wind

when a line carries a number of ice coated wires, some of the wires offer an appreciable amount of wind shielding to other wires on the line. In areas where ice is a factor, and in those cases where the poles carry a sufficiently large group of wires to furnish effective shielding, allowance is made for such shielding in the amount of strength provided in the pole structure. It might be noted in this connection that while the effect of shielding on a group of wires is such, in the aggregate, that recognition can be given it in the pole design, no account can ordinarily be taken of it in considering the effects of wind and ice on individual wires.

IT is an entirely practicable matter to design both the wire and pole plant to withstand specified amounts of ice and wind, but it is not feasible, except in a general way, to design against the widely variable loads and conditions imposed by trees broken or uprooted by ice and wind. The wire plant is particularly vulnerable to damage by ice-laden trees, and a great deal of the subscriber distribution plant is unavoidably exposed to possible tree damage. An example of this type of trouble is shown in Figure 11. The insulated wire which forms the subscriber's service connection from pole to house, and which often must thread its way between the trees on side-walk and lawn, is particularly subject to damage of this type.

As an example, in one severe ice storm which affected certain areas in southern New England, New York, and New Jersey during the past winter, fully 90 per cent of the interruptions to subscribers' service were due to trees or the branches of trees

Fig. 11. TREE BREAK

Where wires may support the weight of ice alone, the added burden of tree limbs sometimes brings them down

falling across the insulated wire connecting the subscriber's premises with the telephone system. Relatively few breaks occurred in these service connections other than those caused by trees. Although on account of its strength bronze wire is used for the house connection and the policy is followed of avoiding trees as far as practicable, it is inevitable that some damage to aerial house connections should occur at these times. In order to insure against interruption of service from such causes, the Telephone Company and the individual subscriber frequently coöperate to place the house connection underground.

Coping With Ice Loads

Needless to say, to provide economically against damage and service interruptions due to ice and wind requires an intimate knowledge of the conditions which must be met. The severity and frequency of storms may vary widely between adjoining areas. The direction of the line with respect to the winds which prevail at the time of ice storms is also important, as is the effect of wind breaks offered by hills and woods. Finally there is the question of how great an expenditure for extra strength can be justified from a service insurance standpoint; a transcontinental circuit, for exam-

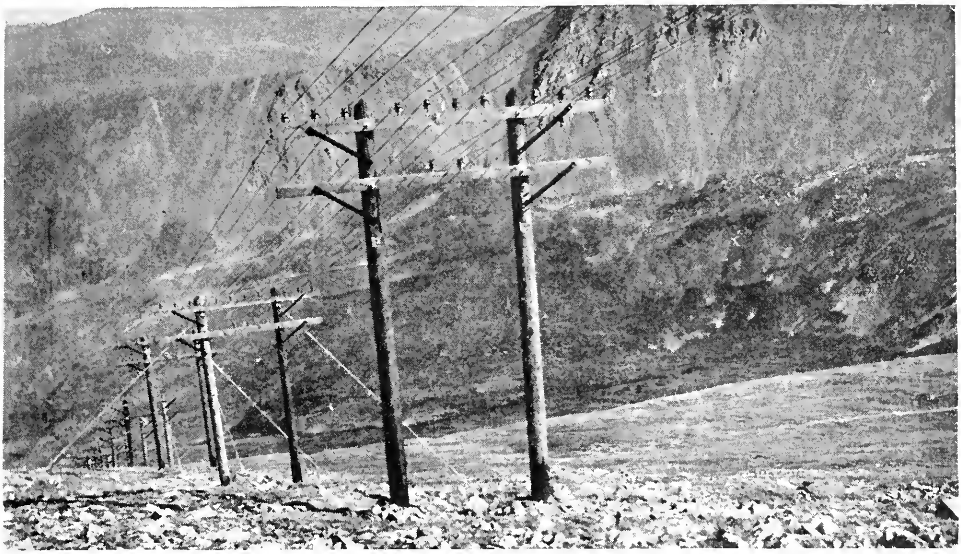

FIG. 12. H FIXTURES

Construction on the Argentine Pass, in the Rocky Mountains, to withstand unusual stresses

ple, justifies greater strength than an exchange circuit only half a mile long.

First thought must be given to the wires themselves. In the Bell System, hard-drawn copper and galvanized steel wire are the types used chiefly for open wire circuits. Size for size, steel wire is stronger than copper and is better mechanically than copper in other ways; but copper wire, having a much lower electrical resistance per unit of length, has important advantages from the standpoints of both voice transmission and the transmission of the necessary signals between the central office and subscriber or between central offices. Under many conditions, however, galvanized steel wire is a highly satisfactory material for open wire construction, particularly in exchange and rural lines. This is particularly true now that galvanized wire can be obtained with various weights of galvanizing designed to meet different degrees of corrosion to which it may be exposed in service in different localities.

Hard-drawn copper wire in the Bell System is, generally speaking, confined to four standard sizes having diameters of .080, .104, .128 and .165 inches, respectively, and with the breaking strengths ranging from 330 pounds for the .080 wire to 1325 pounds for the .165 wire. For the country as a whole, the .104 size is the most commonly used, .080 being limited largely to areas where ice is not a particular factor and the .128 or .165 size being used in toll circuits where greater insurance against the breaking and stretching of wire is desired.

IN Figure 12 are shown so-called H fixtures on the eastern slope of Argentine Pass in the Rocky Mountains in Colorado, on which all the wires are of

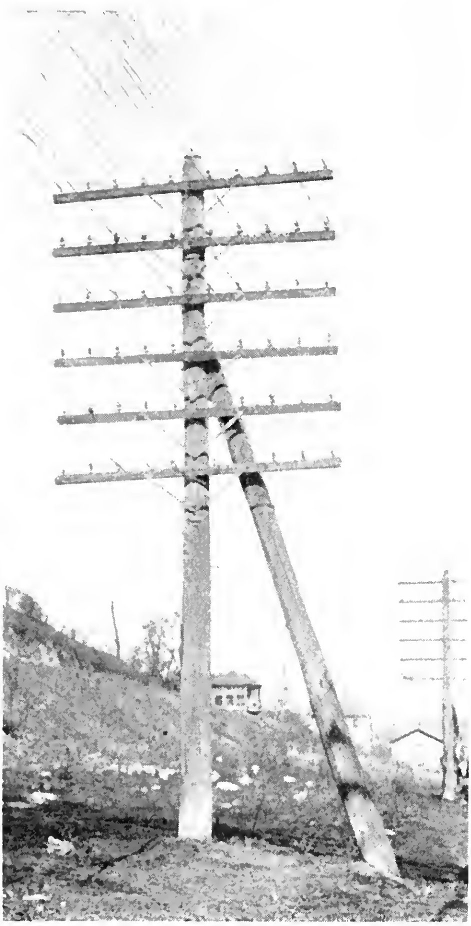

Fig. 13. Push-pull Brace

This type of construction gives added strength to a pole where needed

the .165 size and on which, on account of the extremely severe conditions, short spacing between the poles is used as well. For a short distance where this line crosses the topmost portion of the continental divide, the line strength is still further increased by substituting for each of the .165 copper wires a stranded galvanized steel cable having a breaking strength of 4000 pounds. In the sections where the steel strand is used, sections of poles are bolted across the tops of the fixtures to carry the wires instead of the sawed crossarms shown in Figure 12.

Some use has been made of bronze or other types of higher-strength wire where necessary to meet special conditions. The familiar rubber-covered wire used to make service connections to subscriber's premises is bronze, because its greater strength permits a smaller wire to be employed than otherwise, which is desirable from an appearance standpoint. Bronze has a higher electrical resistance than copper, but this is not important here since the length used is relatively short.

Naturally, the length of span with which a line is constructed affects the loads on both the line wire and on the poles. In the highest grade toll lines, where the maximum insurance is essential against breakage and stretching of the copper wire, span lengths are generally limited to about 130 feet. On lines carrying circuits of a less critical character, longer spans may be used after giving due weight to the service conditions, exposure to storms, strength of wire used, size of poles, and possible effects on maintenance. In rural lines employing high strength steel wire which has a breaking strength in excess of 1200 pounds, span lengths of 350 feet in heavy storm areas and 450 feet in medium storm areas are commonly used.

In building and maintaining lines, it is standard practice in the Bell System to use poles of a diameter and strength which are in keeping with the particular storm exposures concerned, the wire load carried, and the character of the facilities on the line. Also, corresponding adequate minimum strength standards have been established for poles in service; and to ensure the maintenance of strength in excess of these minimum values, systematic recurring inspections are made of poles in plant. Poles which are found on these routine inspections to be approaching these minimum strength standards as the result of mechanical damage or deterioration through insect attack or decay are either replaced or strengthened. By thus watching carefully both the strength new and the replacement strength of the pole lines, breakage of poles due to storms is minimized. A record kept over 15 years and embracing many millions of poles throughout the Bell System shows that the yearly breakage due to ice storms amounts to only a small fraction of one per cent of poles in service. Of this extremely small percentage, many were casualties of falling trees. In fact, if storms were the sole cause of pole failures in the Bell System, the average pole would last 300 years or more.

It might be mentioned here that a large percentage of the poles included in this study had not been treated with a timber preservative prior to installation and, therefore, some were poles which had suffered some loss of strength due to decay but still possessed strength in excess of the replacement standards. Since all but a small percentage of the poles currently being used in the Bell System are treated with preservative before installation, and since the resistance of treated timber to decay greatly increases its reliability in service, breakage due to storms will be reduced to even lower values.

FIG. 14. AERIAL CABLE

With many wires enclosed in a lead sheath, aerial toll cable is largely immune to damage from ice and wind

WITH recurring inspections of poles in service usually made at intervals of three to six years, depending on the reliability of the pole timber and whether or not it has been given a preservative treatment, the opportunity is afforded to single out the occasional deteriorated pole for replacement or repair. Thus the strength of the line as a whole is maintained at levels well above the minimum for individual poles. As a matter of fact, new poles as installed ordinarily provide a degree of strength materially above the minimum required of such new poles, and it follows, therefore, that many lines have a strength at all times appreciably in excess of the minimum strengths required of new lines.

It is axiomatic that good engineering requires proper consideration of economic as well as mechanical principles. It is obvious that a plant so designed that no pole would ever be broken in the course of a storm would both be wasteful of our timber resources and result in unnecessary and perhaps prohibitive cost to the user of telephone service. There must be a balance between strength and the cost of the insurance which extra strength provides, and this point of balance can only be established through experience combined with engineering judgment. While it is eminently proper that there should be general minimum strength standards for the pole plant, based on the best possible data accumulated in regard to the extent, severity, and frequency of ice storms, the existence of such data and standards cannot be considered as a substitute for an intimate knowledge of the particular local conditions which must be met on any particular line or section of line.

Accordingly, in the Bell System, while there are generally accepted and very definite minimum strength standards, the engineers responsible for the construction and maintenance in local areas must determine to what extent these minimum standards should be raised to meet any particular conditions which may be encountered in their areas. For example, a river valley for a limited distance away from the river may be subject to heavy ice and frost accumulation, a line through a flat treeless area may be particularly exposed to wind as well as ice, or additional insurance may be desirable for a line whose failure would result in serious service interruptions because of the outstanding importance of the line.

Additional strength may be provided by various means, such as stronger poles or wire, heavier crossarms, shorter spans, stouter guying, and by pole fixtures of various types. One type of strengthening fixture is the H fixture shown in Figure 12. Another is the push-pull brace, Figure 13.

The Bell System Cable Network

EACH aerial wire on a line picks up its own quota of ice, and when this is multiplied by 30 or 40 wires, there is considerable sail area exposed to the wind by the whole line. On the other hand, where the number of circuits warrants, several hundred or even thousand wires may be gathered together under a common lead sheath forming a cable of less than three inches in diameter. Such a cable, when it has accumulated a heavy ice coating, will present no more area to the wind than half a dozen similarly coated open wires. Moreover, in order to provide large strength margins to permit aerial cables to support safely the weight of men employed in their construction and maintenance, it is the practice to support aerial cables on stranded steel "messengers," some of which have breaking strengths

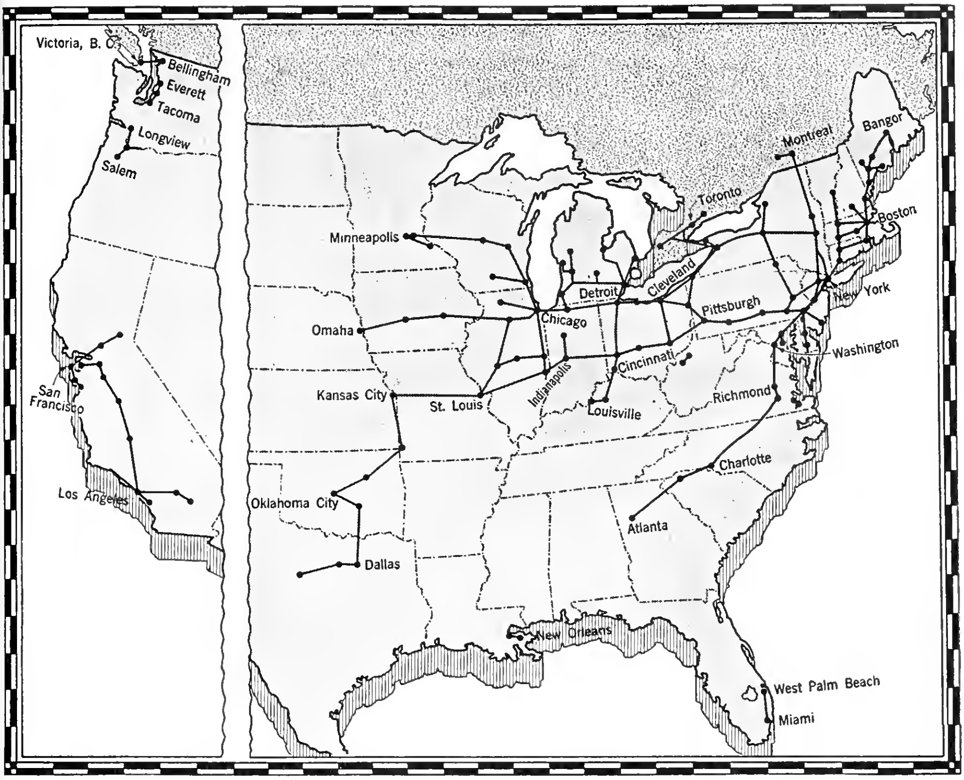

FIG. 15. THE BELL SYSTEM'S BASIC TOLL CABLE NETWORK

This map has been abbreviated to show only the arterial cable routes already in service. Many important additions are planned, including a 1,600-mile extension from Omaha to San Francisco, touching Denver and passing through Cheyenne, Salt Lake City, and Reno, and thus providing cable circuits from coast to coast, on which work is being begun this fall

as high as 25,000 lbs. Consequently, ice accumulations on aerial cable, even if accompanied by wind, do not have the adverse effect that they do on open wire, and relatively high line strengths can be obtained for aerial cable lines rather easily and at moderate cost. For this reason aerial cable becomes a practically stormproof plant. Such a line is shown in Figure 14, which is a photograph of a long distance telephone cable extending from Greenfield, Massachusetts, to White River Junction, Vermont. Incidentally, this cable remained continuously in service during the hurricane of September, 1938, despite the fact that after the storm it was necessary to remove many hundreds of trees which had been blown across it.

CABLE placed in underground conduits, or specially protected cable buried directly in the earth, is, of course, immune to the effects of ice and wind storms. It offers, as well, service insurance in other directions as, for example, against trouble due to bullets or fire. In the Bell System plant there are more than 71 million miles of exchange wire (i.e., wires used for providing local telephone service), of which approximately 65 per cent is underground, 32 per cent in aerial cable, and the remaining 3 per cent in aerial wire. Of the System's 16 million miles of toll wire, about 43 per cent is underground, 41 per cent in aerial cable, and 16 per cent in aerial wire. The fact that the percentage of aerial wire is greater in the toll than in the exchange plant is due largely to the fact that the smaller number of toll circuits makes it more difficult to justify cable economically.

The Basic Cable Network

In Figure 15 is shown the Bell System's basic arterial network of long toll cables. There are, of course, thousands of other cables not shown which are either tributary to these or which make up an interlacing network between the primary routes. These primary routes offer a practically storm-proof service over the more densely settled portions of the country and are being constantly extended as fast as they can be justified from service and cost standpoints. One of the latest of these to be completed is the new cable between Stevens Point, Wisconsin, and Minneapolis, which, together with an existing cable from Chicago to Stevens Point, connects Minneapolis and St. Paul with the backbone cable network.

This new cable, of the coaxial type to carry several hundred messages ultimately, was for the major part of its length placed underground by means of a specially designed train of power-operated equipment which takes the cable from the reel on which it is supplied by the Western Electric Company and installs it underground at depths of 36 to 48 inches as conditions demand. In Figure 16 is shown an installation train consisting of the cable plow pulled by two tractors and followed by the reel on which the cable is delivered. A similar cable installation is now being made between Washington and Baltimore to supplement existing cables between these cities. This new cable is being placed over a route well separated from the existing one, to provide further service insurance. Work is also beginning this fall on an important extension from Omaha to San Francisco which will provide cable circuits from coast to coast.

The fact that there appear to be considerable areas not yet covered by these backbone cable routes does not mean that adequate protection is not being given in these areas against possible interruptions due to storm damage. In the section from the mid-west to the Pacific coast, for example, there are four transcontinental open wire lines: one from Chicago through Minneapolis, Fargo, Bismark, and Helena to Seattle; another between Omaha and San Francisco via Denver, Cheyenne, and Salt Lake City; and two southern routes to Los Angeles and San Francisco, one from Oklahoma City and the other from Dallas and Fort Worth. In addition, there are north and south tie-lines both along the Pacific coast and east of the Rocky Mountains. In the event of failure of the most northern route, for example, service to Seattle from the east can be furnished over the central or southern routes via either San Francisco or Los Angeles. Such service insurance is likewise furnished in the southern states through a similar network which provides for alternative and emergency routings.

It might be of interest to note here that the installation of new toll cable is now under way between Amarillo, Texas, and Tucumcari, New Mexico, to overcome difficulties with ice storms which have caused some interruptions to the open wire circuits in this section of this southern route.

TELEPHONE communication cannot be simply a fair weather service, for its value is often greatest when conditions are worst. To ensure continuity of service, plans must be made in good weather to meet conditions in bad. Adequate strength margins must be included in new aerial plant and maintenance must keep this strength at proper levels. Nature is no respecter of persons or things, and when she cannot be met by frontal attack she must be overcome by circumvention—by the substitution of aerial cable for open wire, by placing cables underground, by the provision of alternative routes for backbone circuits, and by providing a plant which has the flexibility which will permit of rapid adjustments in time of emergency.

To the telephone engineers this never ending battle against the destructive powers of the elements is fascinating. It is a fair fight, a continuation of the one begun when primitive man first sought the caves to escape those same elements. In this modern age the struggle has countless ramifications. As we are so often reminded, our civilization is built on power, transportation, and communications. The public resents even temporary failures on the part of any one of these three great servants. In the telephone field, as in the others, the public's standards become more and more exacting. The telephone engineer does not decry this but, instead, seeks new ways to circumvent the whirlwind attacks which less and less frequently result in interruptions to telephone service at the time it is most needed.

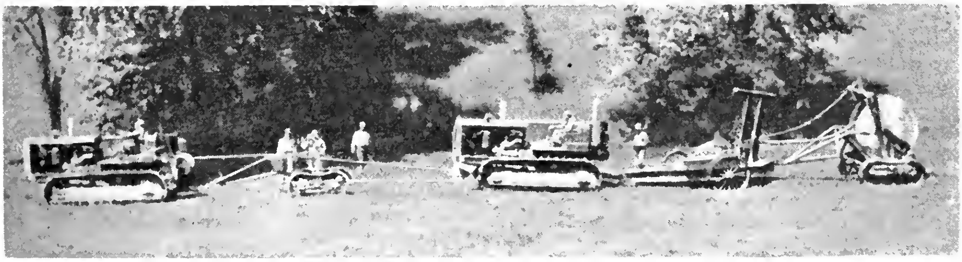

FIG. 16. PLOWING TELEPHONE CABLE UNDERGROUND

This powerful tractor-plow-trailer train places cable underground to a depth of three to four feet, the cable being fed automatically from the reel at the rear through the plow directly ahead

AT THE CUSTOMER'S SERVICE

Residence and Business Services and Equipment Are Available in Wide Variety to Meet Telephone Users' Many Different Needs Conveniently, Efficiently, and Economically

By JUDSON S. BRADLEY

The growth in number of telephones in the United States to the present record total of more than twenty-one millions is a well-known fact, as is their geographic distribution throughout the length and breadth of the country. Less well known is the wide variety of telephone services, and of the instruments through which these services are rendered. Indeed, so many are there and so different and often specialized are their applications that only those in the business who in one way or another have directly to do with them can be well acquainted with them all. Yet, since they are one measure of the scope of Bell System service, some description of the more outstanding of them may be of general interest.*

A beginning may well be made with the services and telephones which are available for residential use, since they are fewer and less complex than those which may be needed for a large business installation. And the logical place to start is with the line between the subscriber's premises and the central office.

An individual line is preferable, of course, since it is used only in the subscriber's own service. A "party line," shared with others but having a lower charge, may prove satisfactory if the family is small and the use, both outward and incoming, limited. Nor is one line the ultimate. A large household, whose members have many interests and activities, may very well have two central office lines—or more. It is not unusual for a big estate, or even an elaborate apartment, to be as well equipped telephone-wise as a business office.

Central-office lines connect with telephones. Of the latter, half a dozen kinds, at least, are available for household use.

The handset, lying in its mounting, and with the bell box placed inconspicuously nearby, is appropriate to any room. So is the combined handset, which includes, in a larger base,

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* Omitted from consideration here are certain services and equipment of such specialized application as not to be of general interest; also long distance and teletypewriter services, and public telephones, which have been described in previous issues of the QUARTERLY.

COMFORT AND CONVENIENCE

Few things contribute more to domestic ease than telephones in the right places

the bell and necessary electrical equipment, and thus eliminates the bell box.

The handset can be had, just as readily, to hang on the wall or to be affixed to a shelf; it is most convenient for kitchen, pantry, hall, or other location where space is limited. A portable telephone can be plugged into special outlets much as are electric fans or vacuum cleaners, offering a courtesy in the guest room and a step-saver in other parts of the house. There is a telephone made especially to fasten permanently on the wall; the desk telephone is still available if one prefers that type; an outdoor telephone comes in weather-proof case for garden, tennis court, or elsewhere about the grounds. Indeed, if harmony in the decorative scheme of any room is important, telephones can be had in dark gold, old brass, oxidized silver, statuary bronze, dark blue, gray-green, ivory, old rose, or Pekin red.

If some member of the household has impaired hearing, the amplifying equipment which can be connected to any telephone may be a real blessing. Developed to help the partially deaf to use the telephone freely, it offers varying degrees of amplification of the voice in the receiver, the loudness being varied by a control button. While it is a permanent installation, it is connected and disconnected by the flip of a switch, and the telephone is always available for use by those of normal hearing.

In the big-city one-room apartment,

A PORTABLE TELEPHONE HELPS HERE

Many hospitals are equipped for this service, which can bring cheer during lonely hours and keep the patient in touch with home or business affairs

a telephone doubtless meets the situation fully. Double the number of rooms, and you lessen the convenience of one telephone; for if it is handy by the bed at night, it means running into the bedroom to answer it or to make a call during the day, while if it is in the other room, the ease and protection of the bedside telephone is lacking. Thus in a two-room home an extension as well as the main telephone may prove convenient; and the change from one room to two illustrates the point that, as the number of rooms increases, so does the importance of having more than one telephone.

A home of two or more stories which has but one telephone is—as a generalization—not only inconveniently but inadequately equipped. Better in every way is a minimum of one telephone on the first floor and one on the second, not only to save running up and down stairs, but to make it possible to answer a call before the caller concludes that no one is at home and hangs up, his call unanswered.

Still more convenient are an extension in the master bedroom, another in the kitchen, and the main telephone in the living room, library, or other convenient location. The larger the home, the greater the need for extension telephones, for in the modern household, equipped with up-to-date appliances from radio to vacuum cleaner and electric refrigerator, its members will not expect to deprive themselves of the convenience of telephones where they will be handy.

Auxiliary Equipment

"I HOPE it's for me" said the headline of a recent Bell System advertisement which pictured the members of a family all hurrying to answer the telephone. Obviously, the bell had rung, and its sound was an expectant summons. Perhaps chief of all the advantages of the telephone is that it is a *two-way* medium of communication, and consequently there must be some signal to let us know when someone wishes to speak with us. But the familiar b-r-r-r-ring is not the only kind of bell, nor, indeed, is it always the most desirable form of signal. There are bells of different tones, such as the signal which strikes one soft musical note—but since this can scarcely be heard beyond one room, it is usually not the only bell in the house. Louder bells—gongs, really—can be installed where it is necessary to hear them at a distance.

Lights, too, may be used as signals, although in the home they are generally used only as supplements to bells. Where there are two lines, for example, a common bell can serve to announce a call on either one and differently colored lights at the telephone show which line the call is on. Two bells of different tones would, of course, accomplish the same purpose. Like the bells, the lamps are designed to fit various needs.

There may be times when the sound of a bell is not desired. Particularly is this true of a bedroom extension when there is sickness or when the bell would interrupt needed sleep. A remedy for this is a simple little switch which cuts off the extension bell—but not the telephone—until it is thrown "on" again. Another switch, equally simple, will disconnect all extension telephones at will, thus insuring absolute privacy of the conversation over the telephone in use. Again, a call may be answered at one telephone and another person summoned, by

EFFICIENCY IN THE KITCHEN

The hang-up handset makes it possible to keep an eye on the cooking while holding a conversation means of buzzer signals, to answer it at another telephone.

WHEN two or more central-office lines enter the home, all lines may be used for both outgoing and incoming calls, of course—although in some households it is the practice to limit service calls to one line, so that the other line or lines may be always free for use by members of the family. Since an establishment large enough to require several lines will have extension telephones in all important rooms, both family and service, it becomes increasingly convenient—important, in fact—to be able to use them for intercommunication throughout the house and other buildings. Likewise, the service must have flexibility: it must be so arranged that incoming calls may be answered either at any telephone or at certain designated telephones; that a call may be transferred readily from one telephone to another; that a call may be held at one telephone while another call is placed to a different instrument; and various combinations of these and other features which meet the needs of the ménage.

All of these needs, in their many variations, and to the greater or less extent required, may be provided for through the many standard layouts which meet almost any requirement. The simpler layouts call for only the wiring and the buttons and keys; the more complex arrangements take, additionally, a cabinet in some out-of-the-way location to house the necessary associated equipment. Simple or complex in planning and installation, they are all easy to use, and bring to the big home or the more modest domicile a convenience in proportion to the needs they serve.

Lines, instruments, extensions, signals, switching arrangements:—even these brief descriptions give some idea of how broad is the scope of residence telephone service. On the subject of the telephone in the home, there is, however, a final point to cover: the telephone directory.

THE directory, of course, furnishes the subscriber's telephone address. Normally, one simple listing gives all the necessary information:

Doe John r 123 Main	4567

If Mr. Doe carries on a business under his own name, however, he may prefer to have both business and residence telephones listed thus:

Doe John ofc 321 State	6745
residence 123 Main	4567

If he has more than one central-office line, he may prefer to have this kind of listing:

Doe John r 123 Main	4567
Service	5678

If Mr. Doe's residence is in the suburbs, for instance, and his service is furnished through an exchange other than that of the nearby city, he may carry in the latter directory a listing like this:

Doe John r 123 Main Othertown (Dial Operator) ...	Othertown 4567

One way or another, the directory can make Mr. Doe's residence easy to locate, easy to reach by telephone. That is fine for him and Mrs. Doe. What about other members of the family? If there is in the household someone with a different surname—nephew or in-law, for example—that person may have an individual listing.

Without it, only those who know, and remember, that Mrs. Richard Roe makes her home with John Doe will be able to reach her; to others she will be telephonically anonymous.

So we see that even as prosaic a compilation as the telephone directory can add greatly to the convenience of residence telephone service.

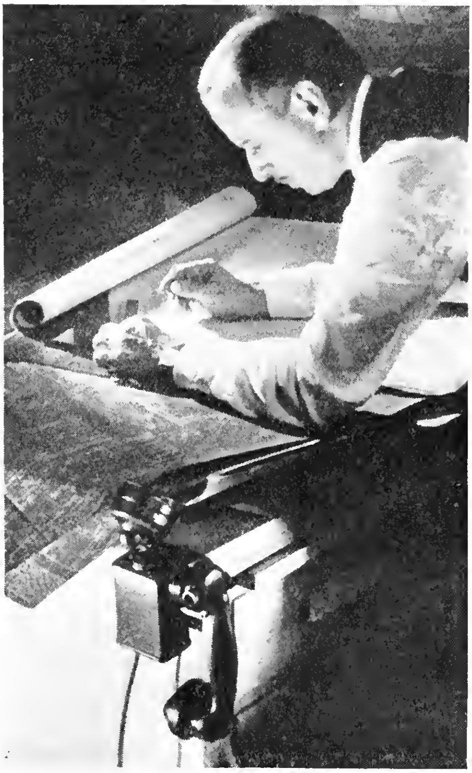
The Great Variety of Services and Equipment for Business

Much wider is the field of business services and equipment. Discussion of them may conveniently start, as did the previous section, with the matter of lines—about which there is not a great deal to say. For, invariably, the individual central-office line is the principal servant of business, be the requirements of an enterprise met fully by a single line or by two score.

As for telephones:—all those which were described earlier as suitable for residence service have their places in business, and there are numerous others for special uses.

Many an executive office is fitted with a telephone in bronze or other metallic finish, or, if the decoration is modernistic, with one in color. The hang-up handset keeps desk or counter unencumbered. The desk set still works as well as ever. The wall set also has its place. The outdoor telephone, in its weatherproof housing, is most often useful on loading dock, in supply yard, or other exposed location. Portable telephones find a variety of business uses.

The amplifying equipment has a further refinement often helpful to the business man whose hearing is impaired: a microphone, to be placed on desk or table, which is connected with the amplifying circuit. A person's words addressed to the microphone are stepped up through the equipment to the telephone receiver, to which the hearer listens as to an ordinary telephone conversation. Operation of this equipment does not exclude incoming telephone calls.



Out of the Way

The hang-up handset in the office keeps desk or table surface clear

In addition to telephones which are equally useful in home or business, there are others which have been designed primarily to meet some particular use in business.

Such as telephones in elevators, for instance. With one in each car, and connected through a switchboard,

Free to Move About

Operator's head-band receiver and chest transmitter, and plug-in (portable) telephone connection, give this clerk freedom of action and speed her work

they insure smooth operation and dispatching on schedule—a prerequisite to any pleasing and convenient transportation service. And should an elevator become stuck, it is most reassuring for the operator to be able to take down a handset and report the trouble.

An operator's telephone, composed of head-band receiver and chest transmitter, is another specialized piece of equipment. Worn regularly by central office operators and by attendants at busy P.B.X. switchboards, it is also a convenience to those who have to do much telephoning or carry on long conversations. Head band receivers, either single or double, are also available for use with a desk telephone; they leave the hands free for writing.

A recent development is a telephone intended for use in plants where the atmosphere may contain such explosive gases as hydrogen, natural or manufactured gas, or vapors of ethyl, ether, gasoline, acetone, alcohols or lacquer solvents, etc. It is so designed that any possible spark is confined within the interior of the instrument.

Allied to telephones—in fact, to be connected with them—are two types of loud speakers which will amplify incoming messages so that they may be heard satisfactorily by groups of up to 100 and 250 respectively. The loud speaker can be switched off and the telephone at the same location switched on, so that two-way conversation between the near and distant points may be held, and the circuit can even be arranged so that both sides of the conversation are audible through the loud speaker. The advantages of loud-speaker hook-up for addressing sales meetings, conferences, etc., over either local or long-distance circuits are obvious.

All the types of signals previously described for residence use have their application to business, and there are others too. Bells and gongs up to 10 inches in diameter can be furnished in either indoor or outdoor style, for use in noisy locations or where they must be heard at a distance, and there is a double-ended klaxon-like horn which rivals John Peel's view halloo as likely to waken the dead.

FOR THOSE WITH IMPAIRED HEARING

The volume of amplification of the voice in the receiver is controlled at the small device at the side of the desk

Lamp signals are much more used in business establishments than in homes. The man whose incoming calls reach him through a P.B.X. switchboard may prefer to have them announced by the lighting of a lamp rather than the ringing of a bell, particularly if his secretary has an audible signal at the extension on which she picks up his calls. If more than one line terminates at his telephone, lamps will indicate which line has a call for him or which line is already in use. Many circuit arrangements in offices, stores, and plants find light signals helpful, and with some they are an essential part. Lamps, alone or grouped, may use a bulb no larger than a dime in diameter; bee-hive lamps, so called, are larger and more readily visible; installation of proper relays makes possible the use of a big and brilliant lamp corresponding to gong or horn and useful in similar places.

CODE-CALLING systems summon an individual not at his regular telephone when there is a call or message for him. Signals at suitable locations may be single-stroke bells, musical notes, horns, or flashing lights, and customarily the individual hearing or seeing his code responds to the P.B.X. attendant from the nearest telephone. One type, entirely separate from the regular telephone system, is, however, usually operated by the P.B.X. attendant, who pushes a button—one of a number in a small cabinet—corresponding with the code signal of the individual to be called. Another

CONVERSATION BY LOUD SPEAKER

This group is listening to an incoming telephone call which is being amplified through the loud speaker on the table

type, which may be installed in association with dial P.B.X. systems, permits the direct dialing of a code signal. The musical tone signals often heard in hospitals or department stores indicate a code-calling system in operation. Paging by means of loud speakers accomplishes a similar purpose and is not, obviously, limited to messages in code.

Meeting Varied Needs

PERHAPS the one thing most conspicuous in a general consideration of switching systems for business use is not their number nor their variety, nor even the ingenuity of some of their arrangements: it is their ability to provide service to meet almost any imaginable communication need. One business may require a switchboard big enough to serve a fair-sized city, miles of wire, hundreds of telephones. Another needs perhaps no more than a pair of telephones so interconnected that a call may be made or answered at either. The first often requires careful study of the situation, special engineering, many man-hours of manufacture and installation. The second will call for no more than wiring according to a stock diagram. Yet no matter how complex the requirements, or how simple, once they have been determined, they can be met.

We are likely to think of switching systems and switchboards in association, yet they are by no means inseparable. Switches, keys, and buttons, with proper wiring, can afford a vast flexibility of communication. One or two features of telephone layouts in residential use were described earlier; others can only be mentioned in the space available here.

Given one central office line or more, and two or more telephones, these layouts can be arranged to provide any or all of the following services: place or receive calls on all lines at one telephone; cut off from a given line all telephones but the one in use; cut off bells; hold a call on one line while making a call on another line over the same telephone; signal and talk between telephones on the same premises without a central office connection. All these things may be accomplished without the aid of an attendant. There are more than 20 standard layout plans for groups of telephones, and about a million Bell telephones equipped with them.

Recently developed is equipment which provides similar services by means of push buttons in the base of the combined handset. Telephones come equipped with one, four, or six buttons, with provision for a maximum of six central office lines and various combinations of the features mentioned in the preceding paragraph. Optional on any of them is a new and ingenious exclusion key for cutting off extension stations. Incorporated in the right-hand bracket of the combined set mounting, it must be pulled up by hand, after lifting the handset, to exclude other telephones on the line, but the act of replacing the handset automatically restores the key to normal—a boon to forgetful users. These systems differ basically from other layouts in that each telephone may be equipped with features to meet the user's wishes.

FLEXIBILITY

Such buttons operate the several features of a telephone layout: in this instance they permit the holding of a call on one line while talking over another line through the same instrument

STILL other types of equipment concentrate a number of lines in a cabinet with keys and lights, so that, for example, the telephones connected with those lines can be answered at a central point when the regular users of the telephones are not at their desks to answer them. Up to forty lines can be so concentrated, and the cabinets are fitted with lights to signal incoming calls and lines in use, and with keys for answering and holding calls. A typical use would be in an office which is the headquarters for salesmen who are out much of the time. An incoming call to any one of their telephones will be signaled at the cabinet, and a secretary can answer and, if necessary, hold the call while she obtains information over another of the lines multipled through the cabinet. Where two persons facing each other across a desk are to use a

AT ONE'S FINGER TIPS

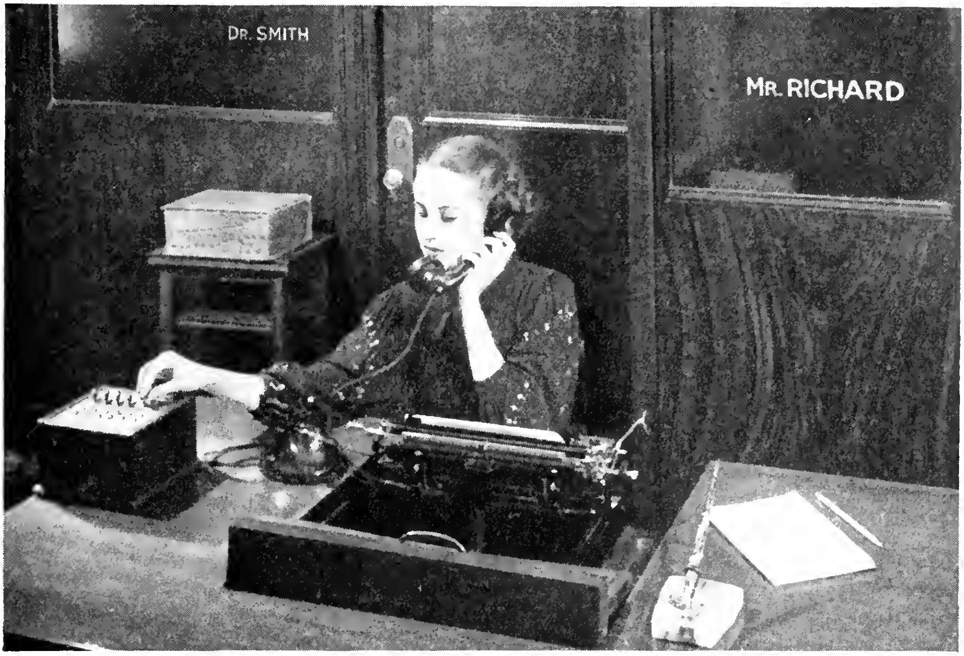
The buttons which control the various operations of a telephone layout are incorporated in the base of this instrument

cabinet, it may be had with facilities to permit both to use it at the same time.

If communication is the blood stream of business, then the private branch exchange switchboard is the heart of every sizable organization, for through it circulate its telephone calls: incoming, outgoing, and among its members. While the arrangements heretofore described have performed varying services, as dictated by the needs they met, the P.B.X., whether manual or dial, has one principal function: to switch calls.

Smallest and simplest of the manual P.B.X.'s are the key switchboards, small cabinets which may be placed on desk or table. The two sizes have provision for, respectively, three central-office lines and seven extensions, and five central-office lines and twelve extensions. Calls are answered at a telephone wired into the circuits, and switching is by the manipulation of keys on the face of the cabinet. Such switchboards best serve businesses whose traffic volume is not large; they are also useful, for example, to supplement for a department or group the main P.B.X. switchboard which serves the organization as a whole.

When the volume of calls necessitates either more central office lines or more extension telephones within the organization, a cord switchboard may be called for. As the name indicates, calls are completed by connect-



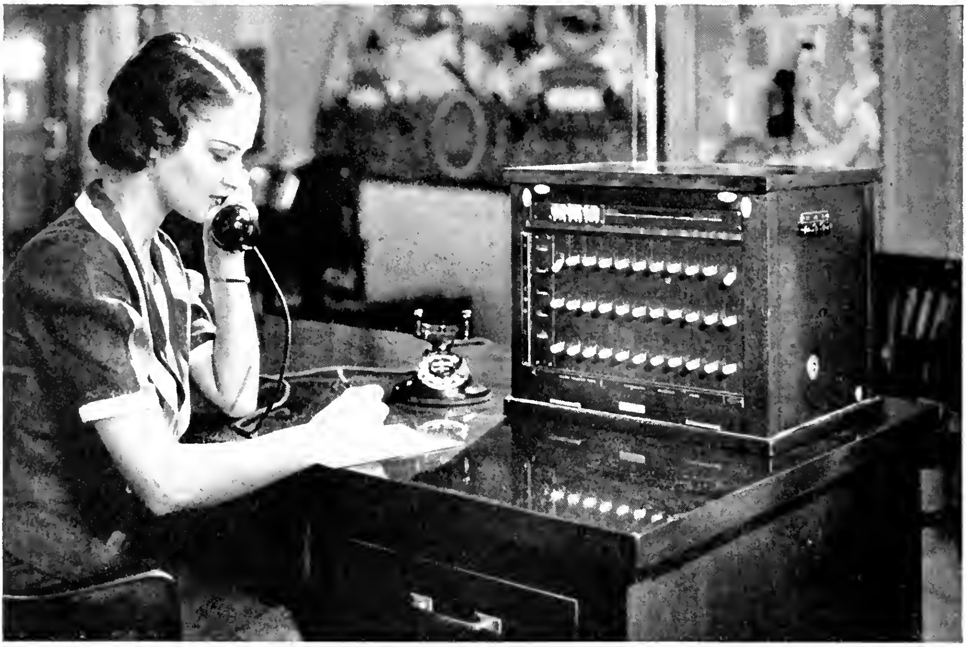
KEY EQUIPMENT

When Dr. Smith, Mr. Richard, and others are away from their offices, this young woman answers their calls by means of the small cabinet on her desk

ing the various lines by means of cords, just as connections are made in manual central offices. Standard cord P.B.X. switchboards have capacity for 10 central office lines and 30 or 40 extension lines, and for 15 central office lines and 80 or 320 extension lines. Depending largely on the traffic load, a switchboard as large as the last named might require the services of two attendants, at least during peak hours, and so be equipped for two positions.

More lines would, obviously, necessitate more positions, and multi-position P.B.X. switchboards are available to serve large organizations. While they are manufactured in standard sections, they are usually installed after a careful survey of the premises they are to serve and the service features they will be called on to provide.

As with manual P.B.X. equipment, there are dial P.B.X. switchboards of many sizes to meet various service needs, ranging upward in capacity from the small cabinet operated by means of keys and a dial-equipped telephone to one capable of handling hundreds of lines. A particular advantage of a dial P.B.X. layout is that members of the organization may dial both their outgoing and their intercommunicating calls direct, without assistance from the P.B.X. attendant. Attendants customarily handle only incoming calls at the P.B.X. For this reason, the switchboard itself of a dial P.B.X. will usually require fewer positions and at-



A SMALL PRIVATE BRANCH EXCHANGE SWITCHBOARD

This key switchboard has a capacity of three central-office lines and seven extensions

tendants than a manual P.B.X. to handle the same number of calls; but the dial P.B.X. system has, of course, the equipment for the mechanical switching of calls which is not required with the manual system.

This is not to say that big dial P.B.X.'s require only a few manual positions and attendants. Many a department store, railroad system, bank, or other large business organization has a dial P.B.X. which serves hundreds or thousands of telephones through miles of wire and requires the services of dozens of attendants who are as thoroughly trained as are the operators in a telephone company's central office. Big P.B.X. switchboards, and all that goes with them, whether manual or dial, are engineered and installed pretty much on a custom tailored basis.

For a detailed account of the many features of P.B.X. switchboards, and of all the kinds of service which may be rendered through them, there is no room here. But, since a P.B.X. is only a means and not an end, some mention must be made of the ends it serves. It will—in simplest terms—connect a central-office line and an extension telephone for inward or outward calls, and will connect one extension telephone with another for inter-communication. But tie lines may join P.B.X. switchboards on the same premises, in different buildings, or even in distant cities; special connections may be set up for night service after the attendant

A LARGE P.B.X. INSTALLATION

Such a private branch exchange switchboard, with its staff of highly trained attendants, can handle thousands of calls a day

has left; the switchboard may be equipped for conference service, so that several people, both on and off the premises, may take part simultaneously in the same discussion. Or a big P.B.X. may reach a smaller P.B.X. which, in turn, serves a department or group. Or it may connect with order receiving equipment.

Order receiving equipment is designed to do one particular job: to answer large numbers of similar incoming calls at a centralized location, and to do it quickly, smoothly, and to the satisfaction of customers. As the name indicates, it is used mainly by department stores, taxicab companies, newspaper classified advertising departments, public utilities, and other organizations with which the public places many orders which may be handled by trained attendants.

The equipment comes as a cabinet to be placed upon a table, and is double-sided: that is, arranged in the center of a table so that attendants on each side have access to the lines between them. Since this sort of order taking is likely to be somewhat of a continuous performance, attendants customarily wear chest transmitter and head-band receiver, leaving both hands free.

Order receiving equipment, like other telephone apparatus, is very flexible in the variety of possible arrangements. It may be connected by trunks to a central office, thus giving customers direct access to the order-taker; it may be reached by extension lines through the firm's P.B.X. switchboard; or a combination of these routes may be employed. It may or may not be equipped to make outward as well as to receive inward

ORDER RECEIVING EQUIPMENT

The clerks in this telephone order department receive thousands of calls from the store's customers every day

calls; it may or may not be linked by tie lines with another switchboard, another order turret or table, or telephones in various departments, on the selling floor, etc. Since the equipment is manufactured in units, these units may be installed side by side to make as large an installation as the incoming business calls for.

THE directory listings already described in connection with residence telephone service are generally applicable to business telephones as well, and there are other ways in which the directory can serve business. Consider these, for instance, which tell their own story:

Doe John J atty ofs 321 State	6745
res 123 Main	4567
If no answer, call	9876
Doe Mfg & Supply Corp	
Main ofc 232 High	5065
Warehouse 454 Elm	7346
Garage 213 State	3794
Nights, Sundays & Holidays call	2038

Transfer of toll charges, whereby department stores, wholesalers, and similar organizations invite customers to call in from "foreign" exchanges without charge, is based, in several different forms, on listings in directories other than the one covering the community in which the organization is located. A department store may arrange to have a listing of which this, for example, is representative, in directories serving exchanges in surrounding towns:

Doe Dept Store 123 Main Centertown	
Ask operator for	WX 1000
(No toll chg for WX calls)	

Calls for WX 1000 are then automatically accepted by the operator as collect toll calls to be charged to the Doe Department Store.

A firm may lease a line to a distant city and list a local number in the latter directory. This gives the firm local representation, telephonically speaking, even though the two ends of the line may be hundreds of miles apart.

Of importance to business men are their classified listings in the "yellow pages," as the classified section of the telephone directory is known. If a firm handles several different lines of merchandise, such as, for example, building materials, weatherstrips, roofing, it can be listed in the yellow pages under each one. Many firms find it desirable to take advertising space in the "yellow pages" to describe their business in a manner to attract prospective customers.

In these ways, and in others not detailed here, the directory becomes an adjunct of telephones which serve business.

INCOMPLETE though it is, this itemization must have conveyed some conception of the variety of ways in which the telephone industry is able to provide services, and the instrumentalities through which those services are rendered, to meet the communication requirements of its customers in almost any form which they may take.

But it is not enough to have all these services, all this equipment, available. Customers must be informed of them, and they must have help in deciding just what particular arrangement will best meet their individual needs. This has led to the development of a special job in the telephone business, that of the customers' communication adviser. This calls for a knowledge not alone of telephone services and equipment but also of business problems and business operations, and for the ability to analyze these as a basis for determining how customers can use the telephone most economically and most efficiently in their businesses.

That the Bell System is able to meet practically any communication need is no accident. Just as, in engineering its buildings, switchboards, and outside plant, the System plans ahead against the demands for service which the future will bring, so does it study today's needs, and anticipate tomorrow's, for the *types* of service and the *kinds* of equipment which will be most fruitful of good for every telephone user. Through the years, one instrument after another has been superseded by another still better, one type of equipment has suggested the usefulness of another type, one kind of service has revealed the opportunity for another kind. As it has been from the beginning, so is it today: studies are continuing, laboratory experiments and models are in process, field tests are being carried on, to the end that the people of this nation may find the telephone of tomorrow serving them in home and farm, in factory and store and office, as steadfastly as it does today—and better.

TESTING AMERICA'S EARS

Records of More Than Half a Million Individual Tests at the Bell System Exhibits at Two World's Fairs Provide the Most Extensive Data Ever Compiled for the Study of Hearing

By FRANKLIN L. HUNT

How good are your ears? This question, which is of personal interest to everyone, has been answered for over three million people by means of tests they have taken at the Bell System exhibits at the World's Fairs in New York and San Francisco during the past two years. More than half a million of the individual tests were recorded for study by the Bell Telephone Laboratories, thus providing by far the most extensive data on the hearing of the American people ever compiled.

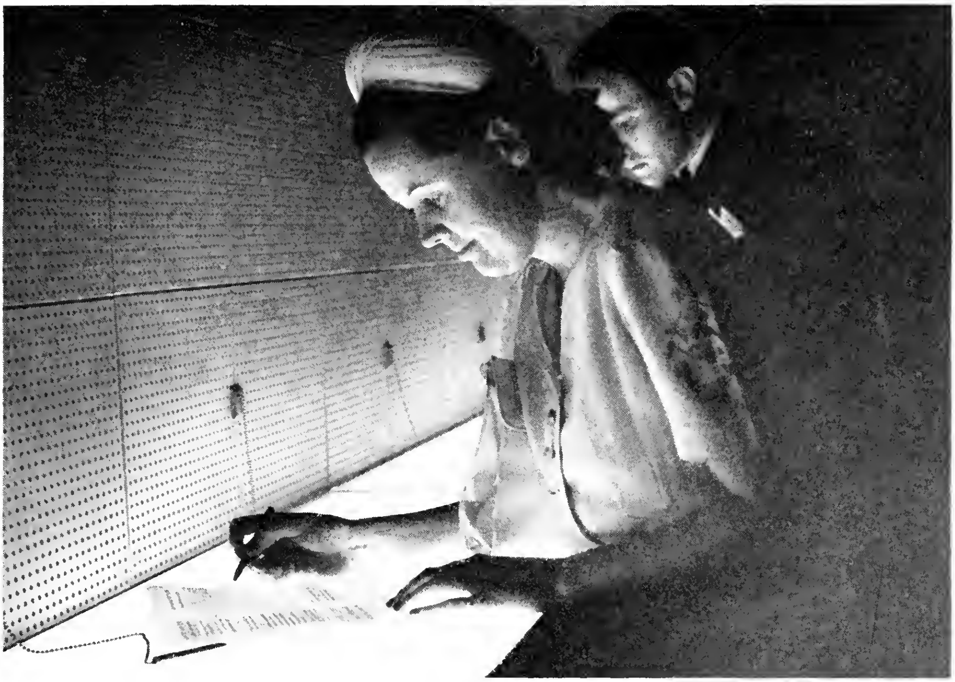
For many years the Laboratories has carried out studies on the characteristics of hearing, for this is the intangible stuff that telephony is concerned with, and knowledge of the behavior of the ear is essential to the maintenance and improvement of telephone service. In keeping with this effort, World's Fair visitors were offered the opportunity to test their hearing.

Information on hearing acuity has previously been limited to tests made on comparatively few individuals. The results of the much more extensive survey at the World's Fairs indicate, as did the previous tests, that there is a definite decrease in hearing acuity with age, particularly for the higher frequencies. At the lower frequencies the loss is small and somewhat less for men than women, but at the higher frequencies men lose considerably more than women.

The tests were made in sound-proof rooms, each of which accommodated seven visitors in partially screened sections. Seated at a table, with a card at hand on which to record the results, the person tested held a telephone receiver to his ear and listened to spoken words or tones which were repeated, with variations—each time fainter than before.

In the word test the visitor heard a series of two-number words, such as "eight five." As successive numbers were spoken, they were recorded in a column on the card, until they became too faint to be heard. When twelve pairs had been announced, the test was repeated with a different series.

Pure musical tones were used in the other test. There were five of them, an octave apart, extending upward from 440 cycles per second—



CHECKING THE HEARING-TEST CARDS

Light passing through the card reveals all the tones which could have been heard and indicates whether the individual's hearing is "normal or good," "slightly impaired," or "impaired"

which corresponds to A above middle C on the piano—to 7040 cycles per second. Beginning with the lowest, the tones were sounded in groups of from one to three pulses—at first loud enough to be heard easily and then fainter and fainter, in from 6 to 10 decibel steps, until only audible by those with exceptionally acute hearing. The number of pulses heard each time was recorded in a column on the card. When the series for the lowest tone had been completed, the tone an octave higher was sounded, at first loud and then progressively fainter. The complete test showed five rows of figures on the card, each corresponding to a different pitch. On the back of the card was printed in reverse the correct number of pulses sounded. By holding the card so that light passed through it, these numbers could be seen and they provided a check on the accuracy of the numbers written down by the visitor. Designations "normal" or "good," "slightly impaired" and "impaired" also showed through the card opposite the 8th, 5th and 2nd steps respectively, to give a qualitative indication of the hearing acuity. From these tone-test cards the hearing studies were made.

Before the person tested left the room, he was asked if he would allow his record to be photographed for

TAKING THE TESTS

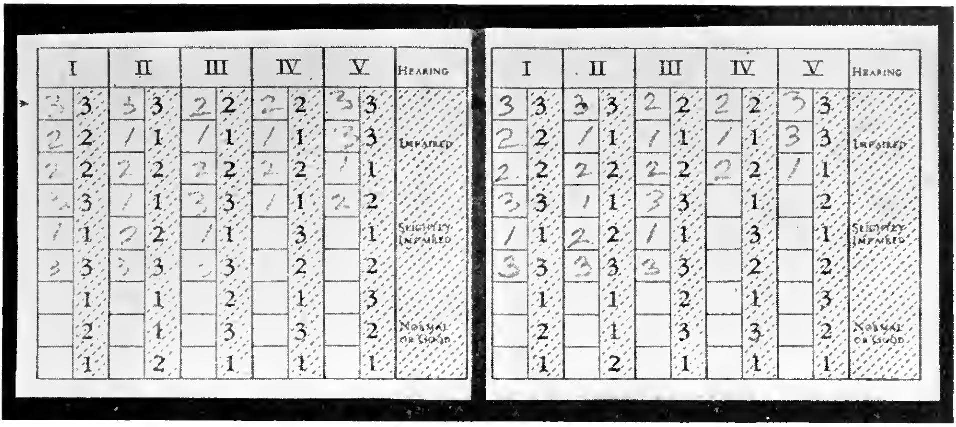
Sound-proof rooms, each containing individual sections such as are shown here, were used at both World's Fairs

analysis. Permission granted, the attendant put a check mark on the card in code to indicate whether the visitor was male or female, white or black, and to which of the five age groups 10–19, 20–29, 30–39, 40–49 or 50–59 he belonged.

A photographic record of the card was then made on 16-millimeter film in a Recordak machine, after which the card was returned to the person tested. These records were transferred to punch cards later at the Laboratories, by an operator who viewed the film in a projector. The punched cards showed, besides the results of the hearing test at each frequency, the age, sex, and the date and hour when the test was made. The data were summarized by running the cards through a tabulating machine.

Equipment for the Tests

To assure that the test tones and the numbers spoken in the word test were always the same, they were recorded on "hill and dale" disc records and reproduced through a standard high-gain amplifier. The recordings were made at a constant level and the fainter levels were attained by switching in attenuating resistance pads between the amplifier and the listener's earphone. This provided a flexible



I		II		III		IV		V		HEARING
3	3	3	3	2	2	2	2	3	3	
2	2	1	1	1	1	1	1	3	3	IMPAIRED
2	2	2	2	2	2	2	2	1	1	
3	3	1	1	3	3	1	1	2	2	
1	1	2	2	1	1		3		1	SLIGHTLY IMPAIRED
3	3	3	3	3	3		2		2	
	1		1		2		1		3	
	2		1		3		3		2	NORMAL OR GOOD
	1		2		1		1		1	

I		II		III		IV		V		HEARING
3	3	3	3	2	2	2	2	3	3	
2	2	1	1	1	1	1	1	3	3	IMPAIRED
2	2	2	2	2	2	2	2	1	1	
3	3	1	1	3	3		1		2	
1	1	2	2	1	1		3		1	SLIGHTLY IMPAIRED
3	3	3	3	3	3		2		2	
	1		1		2		1		3	
	2		1		3		3		2	NORMAL OR GOOD
	1		2		1		1		1	

HEARING-TEST CARDS

These are representative of the average woman (left) and the average man (right) in the 50–59 year group. The many blank spaces in the last two columns indicate loss of hearing

method of adjusting the attenuation and prevented record scratch or noise in the amplifying system from disturbing the listener, particularly for the faint sounds. The pads were connected into and removed from the circuit by a crossbar switch whose contacts were closed by a selector switch operated from a cam geared to the phonograph turn table. To synchronize the tones with the crossbar switch, a notch on the edge of the record fixed its position on the turn table.

Attendants operated the mechanism by a remotely controlled starting mechanism and the equipment stopped automatically at the end of the test. When the starting button was pushed, an auxiliary motor lifted the pick-up from the record and placed it at the starting point. The turn table and synchronized mechanism then started automatically. When the test was completed the turn table stopped and a lamp lighted to indicate that everything was ready for another test. At the New York Fair there were eighteen of these machines and at San Francisco there were four.

To assure a constant output level, the machines were checked carefully each day with a special test record, and all the telephone receivers were tested periodically. Listening tests were also made daily by the engineers in charge and by the attendants.

THE walls of the booths where the tests were made were covered with sound-absorbing material and the floors were carpeted. This assured a low noise level in the test booths. The masking effect of outside noise, as calculated, was less than 5 decibels at the lower frequencies and zero at the higher ones. As a further check, members of the Bell Laboratories' staff who had taken the test at the Fair were retested at the Laboratories under conditions free from disturbing noise. The average improvement was about 3 db at 440 cy-

Source of the Tests

The test tones and numbers were reproduced from "hill and dale" phonograph records through amplifiers to assure constant quality and control of intensity

cles, 1 db at 760 cycles, and the differences were negligible for higher frequencies. Part of this improvement may have been due to repetition, but it indicates the maximum effect of surrounding noise.

Findings from the Tests

The actual losses in db for both men and women for the next to the lowest and next to the highest frequency tested are shown on page 273. Women 55 years old heard the 800 cycles-per-second tones 3 db less well than men, but 3520 cycles they heard 7 db better. For the 10–20 year group there was practically no difference at the lower frequencies and not more than 3 db at the highest frequency. The hearing of the youngest group was found slightly poorer than that of the next older, but it was believed that this was principally due to difficulty which the younger children had in understanding the test procedure.

The difference in the hearing acuity of men and women is also shown on page 273, where the hearing loss for all of the frequencies tested is given for the 10–19, 30–39, and 50–59 year groups. Young men and women hear about equally well at low frequencies, but the women hear about 3 db better at 7040 cycles per second. The difference is much more pronounced, however, in the older group, where men hear about 3 db better at low frequencies, while the reverse holds at the higher ones to the extent of from 5 to 10 db. Zero hearing loss in all of these tests is taken as the hearing acuity of the average of both men and women in the 20–29 year group. This reference level corresponds closely to that for no hearing loss on the 2A Audiometer.

Test cards, as they appear for the average woman and man for the group 50–59 years, are shown on page 269. The lighter numbers at the left of each column are those written down by the person tested, as he listened to the tone pulses. The heavier numbers at the right are those which become visible when light passes through the card; they show the number of pulses actually sounded. Loss of hearing is indi-

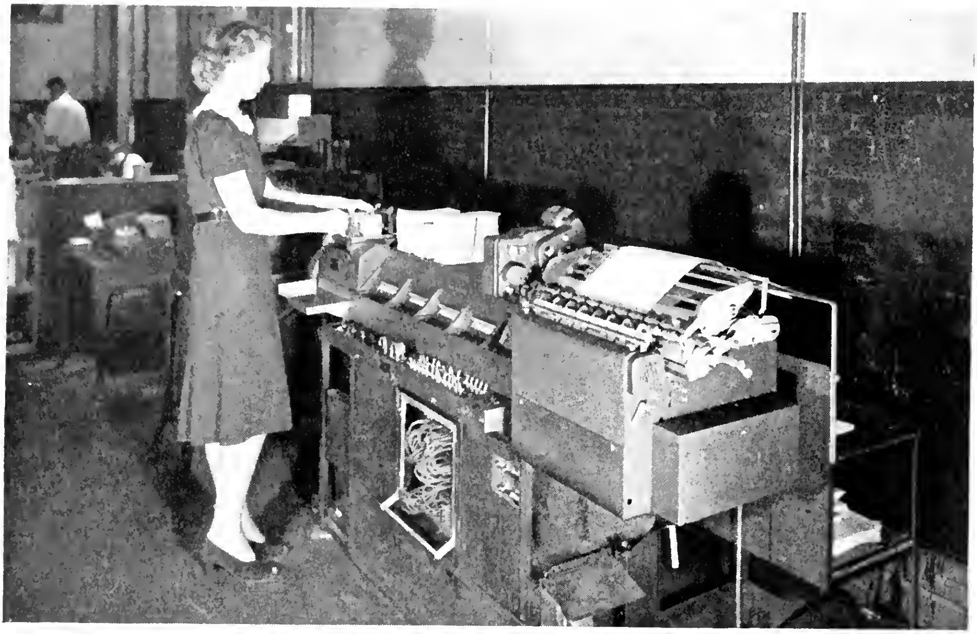
RECORDING RESULTS FROM TEST CARDS

The cards were recorded on 16-mm film, and results were later transferred to "punch cards" by an operator who viewed the film in a projector

cated by the numerous blank spaces in the last two columns. The average young person could hear the first six or seven tone steps but missed the faintest two or three. From 10 to 15 per cent of the youngest group, however, and from 1 to 2 per cent of the oldest group, could hear the faintest sounds.

THE ability to understand speech usually can be predicted from the average hearing loss up to 1,760 cycles per second. An indication of the significance of hearing losses of various magnitudes may be obtained from the collective judgment of deafened people as reported in a survey conducted several years ago by the United States Public Health Service. In that survey, people with hearing losses of 25 db or higher reported difficulty in hearing in auditoriums and churches. Difficulty in hearing direct conversation when the speaker is two or three feet away was reported by people with hearing losses of 45 db or higher, and people with this much loss usually need a hearing aid. Only those people with hearing losses of 65 db or more reported difficulty in hearing telephone conversation.

Combining this information with the World's Fair test results indicates that one out of 25 persons has difficulty in hearing in auditoriums, one in 125 has trouble with direct conversation, and one in 400 has sufficient hearing loss to cause difficulty over the telephone. It is also of interest that only three out of 200 of the young people who took the hear-



SUMMARIZING RESULTS

The hearing test results were summarized by running the punched cards through this calculating machine

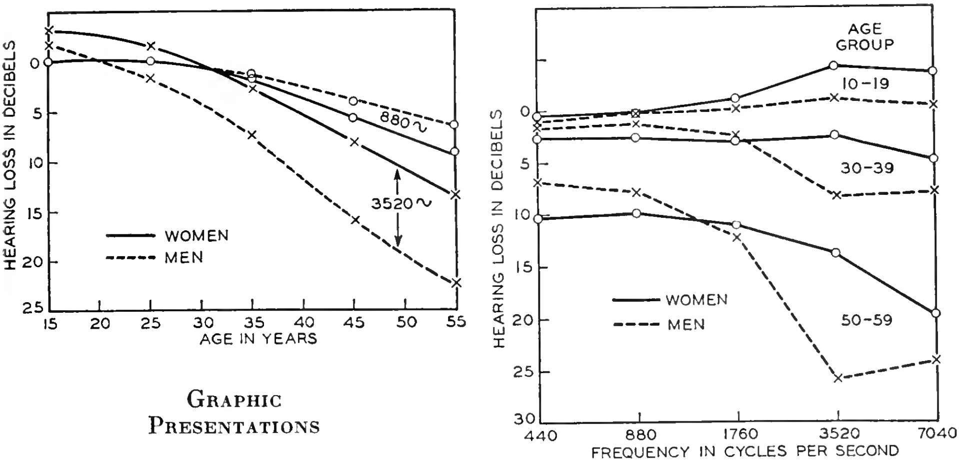
ing test at the Fairs had as much as 25 db hearing loss but that 10 times as many in the oldest group showed this much impairment.

Considering the hearing acuity at the higher frequencies, the World's Fair tests indicated that two out of five men between 50 and 59 years of age showed a loss of at least 25 db at 3,520 cycles per second but only half as many women have this much loss. The tests also showed that one in 20 of the group 10–19 years of age has a loss of 25 db at 7,040 cycles per second, whereas half of the oldest group have losses of this magnitude.

Age and Residence Factors

THE age of those participating in the hearing investigation was estimated by the attendant from their appearance. Approximately fifty different attendants served each week and they were changed about once an hour. To determine the accuracy of the estimates, the actual ages of over two hundred members of the Bell Laboratories' staff and their families, who took the tests without identifying themselves, were compared with the ages recorded on their cards. It was found that 83 per cent were not more than three years outside of the group to which they were assigned.

Comparison of data taken at New York with that from San Francisco for the age groups below 50 years gave no conclusive evidence of sectional differences in hearing. At the three lowest frequencies the differences were insignificant. The results



GRAPHIC PRESENTATIONS

Left: Men hear low frequencies somewhat better than women, but women hear the higher frequencies considerably better than men. Right: Hearing acuity for all frequencies decreases with age and the loss is greatest at the higher frequencies, particularly for men

at 3520 and 7040 cycles per second indicate that the hearing loss of the men who took the test at San Francisco was on the average about 3 db greater.

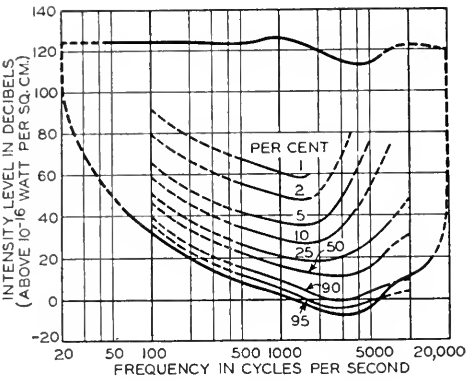
During one week at each fair visitors were asked to indicate on their cards whether they lived in the city where the fair was held, within commuting distance, or beyond. The replies showed that about a quarter of them lived in the city and another quarter were commuters. Although sectional differences in hearing are not very definitely indicated by these tests, the differences found suggest that a more detailed geographical grouping, which also considered past places of residence, might disclose substantial differences.

By observing the appearance of visitors as they handed in their test cards for photographing at the New York Fair, an effort was made to obtain data on the relation of hearing acuity to economic status. Individuals were classed as average and above or below average. The hearing acuity of those above average in personal appearance was found somewhat better.

THE possibility that fatigue might affect hearing acuity was considered. Test cards from both Fairs were studied to see if variations in hearing occurred with the time of day. No consistent difference was found, and it was concluded that there was no appreciable change in hearing between morning and evening for any of the age groups tested.

Comparison of data taken at New York during early summer with that obtained in the fall of 1939 showed no definite difference. This not only indicated that there was no appreciable change in hearing acuity with change in season but it also gave a check on the stability of the test equipment.

A few people, mostly in the youngest age groups, falsified their cards by filling in numbers not heard, but it is



HEARING LIMITS

The lowest curve shows the faintest sounds of different frequencies that a person with excellent hearing can hear; the top curve shows the loudest sounds that the average ear will tolerate. The other curves indicate the faintest sounds that people with different amounts of hearing loss can hear; the figures on them show the per cent of the population having that degree of hearing impairment

believed that the number of these included in the tests was too small to affect appreciably the hearing distribution.

The Fair visitors were probably above average in economic status, intelligence, and education, and it is possible that the hearing of the population as a whole is not quite so good as the tests indicate. Careful consideration of all the known factors leads to the conclusion, however, that the results represent very closely the hearing acuity of the people of this country.

Hearing Loss in the Population

THE hearing tests made at the New York and San Francisco Fairs included a large but not entirely representative section of the people of this country. The age distribution of the visitors was somewhat different from that of the entire population, since the very young and the very old were not adequately represented. By weighting each of the six age groups according to their proportion in the whole population, however, the amount of hearing loss for the ages 10–59 years was computed. The results are shown at the left, where the lowest line indicates the faintest sounds of different frequencies that a person with very good hearing can hear, and the line at the top shows the loudest sounds that the average person can tolerate. These curves were determined by previous investigations.

The other curves, based on the World's Fairs' data, indicate the faintest sounds that people with different amounts of hearing loss can hear and the figures on them show the per cent of the people who cannot hear sounds below these intensities. The intensities are shown at the left of the diagram in decibels. Dotted lines indicate extrapolated values. These results should be applied with caution to groups of unusually high or low economic status without further knowledge of the relation between hearing and these factors.

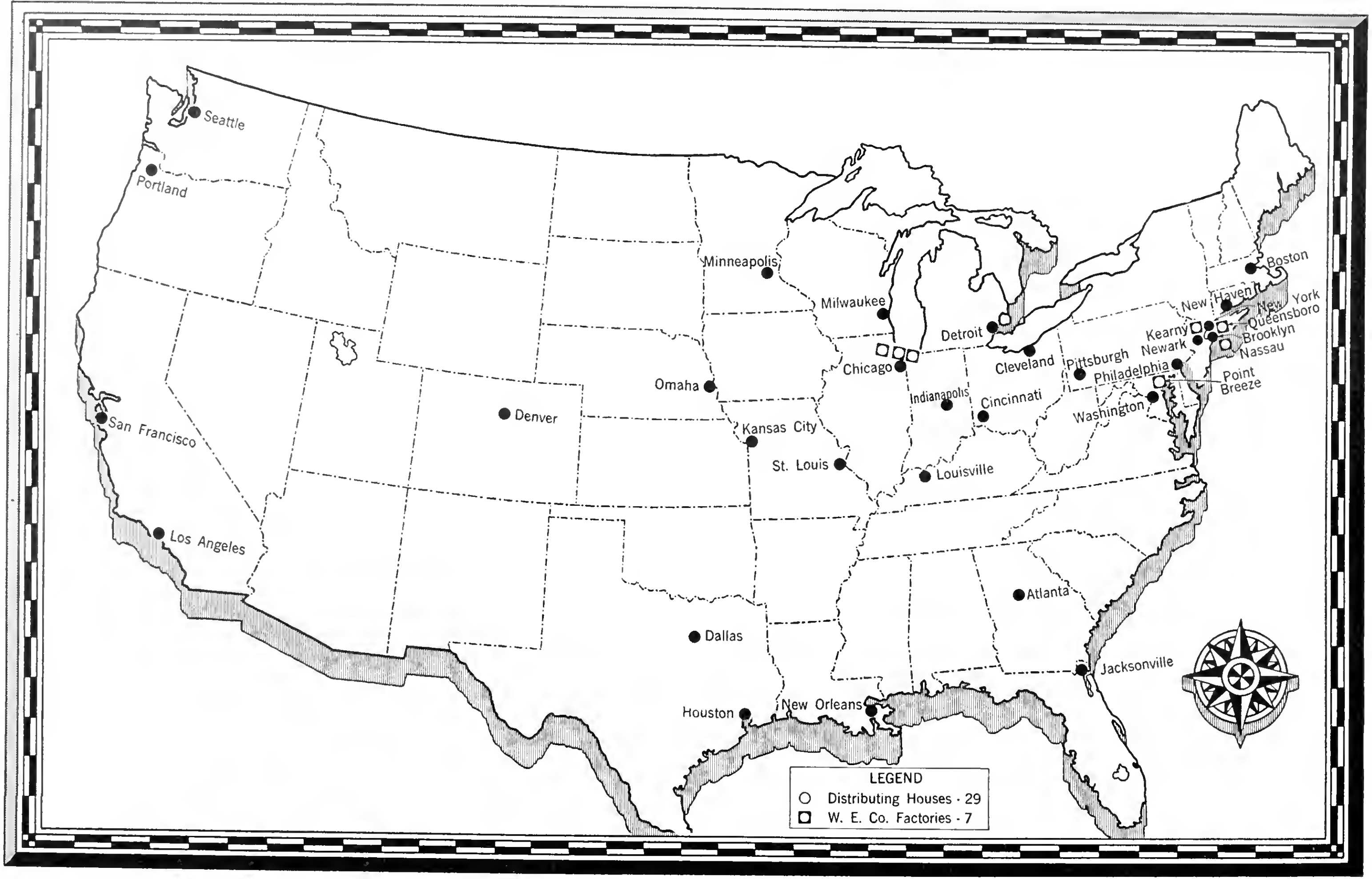
Some normal ears are more acute than the average and others less acute. This makes it important to determine what deviations are associated with the beginning of deafness, particularly among young people. Studies of the Fair data indicate that a smaller hearing loss at low frequencies than at high is significant for both sexes, and that a given loss at high frequencies is more significant for girls than for boys. About 5 per cent of the boys and girls in the youngest group tested had hearing losses at low frequencies which were great enough to cause an appreciable impairment, and from 6 to 8 per cent had such losses at high frequencies.

To help those whose hearing is impaired, the Bell Telephone Laboratories has made available the results of its studies on hearing and the transmission of speech, in the practical form of audiometers to determine their hearing acuity and of audiphones to make good at least in part their hearing loss. Another device, developed for telephone studies, which is helping to teach those with hearing impairment to talk more naturally is the magnetic tape-recorder. This instrument records spoken words magnetically on a steel tape and reproduces them with increased loudness, thus providing a valuable aid for teachers of the hard of hearing.

We have progressed a long way from the traditional ear horn in recent years. Much more effective aids, both preventative and remedial, are now available to those whose hearing is impaired; and it is a satisfaction to the Bell System to have been able to contribute to this cause, through studies which were undertaken primarily for an entirely different purpose, namely, the improvement of the telephone.

WINDOW DISPLAY

To attract visitors and explain the hearing tests, a large illuminated chart was installed in the Bell System exhibits at both Fairs. An attendant behind the round window flashed numbers on the chart as she explained the tests with the aid of a public address system



A NATION-WIDE SOURCE OF SUPPLY

The Western Electric Company's seven factories and twenty-nine distributing houses from coast to coast serve the entire Bell System

FINAL STEPS IN SUPPLY DISTRIBUTION

The Plans Developed to Insure a Continuous Flow of Supplies to Employees on the Job Are Vital Links in the Chain of Bell System Construction, Maintenance, and Operation Activities

By H. CARL RUTH

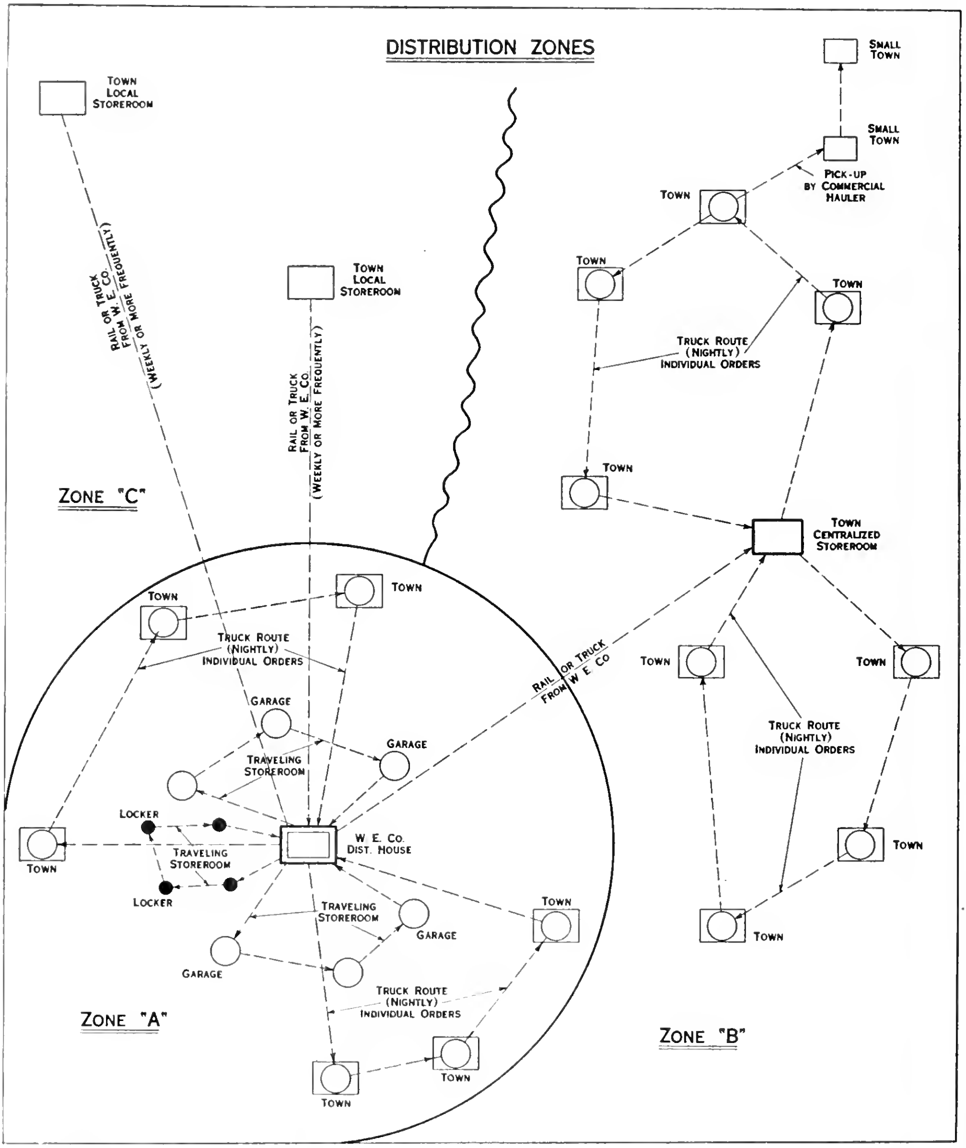
Every working day, the two hundred and seventy thousand employees of the Bell System operating companies use an average of more than six hundred thousand dollars' worth of supplies. Thousands of different items, ranging from a reel of cable weighing several tons to a telephone set or a pencil, must be made available in an orderly and economical way to these workers who construct, maintain and operate this business throughout the nation.

The central source of supplies is, of course, the Western Electric Company, which is the manufacturer and purchasing agent for the Bell System. Western Electric maintains central stocks at its factories and at its twenty-nine strategically located distributing houses throughout the country. The phase of supply distribution dealt with in this article is the movement between these distributing houses and the telephone company employees located in the thousands of communities where Bell System service is furnished to the public. It is the responsibility of the telephone company supply organization in each operating area to provide the methods and facilities that enable the individual employee to have on hand the particular items he needs each day.

The distribution of supplies is not alone a problem of applying the best transportation methods, for many related supply activities must precede and follow the actual transportation between the distributing house and the delivery locations in the telephone company.

Forecasts of requirements for the important items must be prepared to aid in determining manufacturing and purchasing schedules. The output of rehabilitated equipment from the repair shops in the distributing houses must be calculated in advance. Requirements for new items must be estimated. All these are for the purpose of furnishing the Western Electric Company with background information to aid it in maintaining adequate stocks of needed supplies.

The employee needing supplies must know the proper name for each item, the size or code number, the quantities in the standard packages, and whether it is carried in stock at



SCHEMATIC DIAGRAM OF VARIOUS TYPES OF SUPPLY DISTRIBUTION

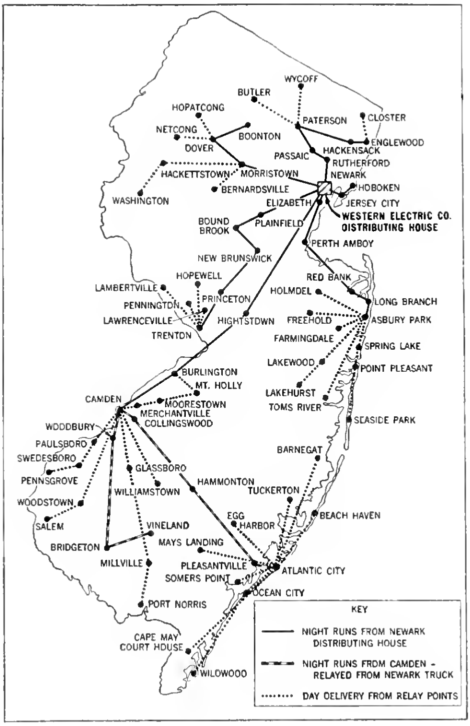
Zone A represents direct distribution from a Western Electric distributing house, Zone B illustrates nightly deliveries from a centralized storeroom, and Zone C shows distribution through localized storerooms

the distributing house. A catalog of supplies is his guide, and the issuance of periodic catalog revisions is a necessary part of the supply work in the telephone companies. Order forms and requisitions are designed in such a manner as to aid the individual to secure the supplies he needs. For the use of the specialized crafts in the Plant Department, the requisition forms are imprinted with the names of the frequently used items.

System in Supply Distribution

It is essential that each distributing house receive an orderly flow of requisitions from the telephone company. Proper time allowances must be made to permit the distributing house to select the supplies and pack them for shipment. Trucking routes must be planned and the time intervals calculated for other forms of transportation from the distributing house to the locations designated by the telephone company. All these factors are carefully coördinated by the telephone company supply organization and the distributing house personnel in preparing the ordering and delivery schedules. For each town, city, and building, and by principal classes of supplies—such as plant supplies, stationery, house service supplies, etc.—the schedules show when each requisition is due at the distributing house and when delivery will be made. The ordering dates are coördinated with the delivery routes, so that the supplies ordered by the various force groups are delivered simultaneously to each building. Copies of these schedules are furnished to all employees who order and return supplies.

As an integral part of the distribution job, the telephone companies' supply organizations must also handle annually some fifty million dollars' worth of telephone sets and other supplies removed from plant, returning them to the distributing houses for testing, repairing and refinishing by the Western Electric Company repair shops.



DIRECT DISTRIBUTION IN PRACTICE

There are no storerooms in the territory of this Bell System company, truck routes from the distributing house covering the entire state

Furnishing the proper types of tools for use by each of the various crafts in the Plant Department is likewise a part of the distribution work. Records of tools in the possession of the various individuals are maintained by the telephone company supply organization, repair standards are set up, and programs aiding in the education of the field forces in the day-to-day upkeep of tools are initiated.

Supervision of the flow of material to prevent unnecessary accumulations of supplies in the field is an important phase of the telephone company supply work. Supply inspectors visit each storage location periodically and also inspect the supplies carried on the work trucks. With their advice and guidance, and with the keen interest of Plant supervision in orderly arrangement and orderly procedures, the field forces have steadily decreased the stocks of supplies carried in the field as related to the quantities they use daily.

The territories utilizing the facilities of Western Electric's distributing houses present varying problems of geography, density of population, types of telephone plant, rate of growth, and organization. Hence, no one detailed plan of supply distribution is applicable to the entire territory of every telephone company. Each operating division must be studied individually and the appropriate plan or combination of plans carefully worked out by the telephone company's supply organization. Engineers of the supply section of the Plant Operation Division of the American Telephone and Telegraph Company take an active part in establishing and improving distribution methods.

Supplies for the Plant Forces

THERE are more than 16,000 motor trucks in the Bell System fleet, each of them carrying supplies and tools needed for the day-to-day work. The supplies required for the routine construction and maintenance of the telephone plant are distributed to this vast fleet, via direct distribution plans, storerooms, and lockers, from the stocks at the Western Electric Company distributing houses by the telephone companies' supply organizations.

Major projects requiring large amounts of cable, conduit, poles, etc., however, must be scheduled in advance and shipped from the factories to the freight sidings nearest the job. The telephone company's supply organization carries on the distribution job from there to the various locations along the line in advance of the actual construction work.

It was the accepted practice for many years for the telephone companies to maintain a storeroom at each location where work trucks were garaged. The stocks in these storerooms were replenished by the placing of bulk requisitions on the distributing houses about once a week.

As the volume of business grew, many of the storerooms within the metropolitan areas surrounding the distributing houses started to place daily requisitions to replenish their stocks in order to meet their increased needs. This helped the storerooms to keep their supply investment at a reasonable level and gave them daily access to the larger stocks at the distributing houses.

It was customary under early methods of storeroom operation for Plant employees to come into the storeroom each morning and get the supplies they needed. In some of the companies, studies were made to ascertain the time required by these field forces to secure and also return supplies to the storerooms. This was found to be considerable in the aggregate, and the next step was the establishment of the so-called night-loading plan, whereby the employee left an order

STOCKING UP

Replenishing the portable shelving units carried in the traveling storerooms

each evening for the supplies he needed the next day. The storeroom force collected these orders each night from the trucks in the adjacent garage, selected the materials from the storeroom stock, and placed the needed supplies on each truck. At the same time the storekeeper picked up the recovered material. This reduced considerably the time required by the field forces to secure and return supplies.

As the types of supplies became more diversified and operating refinements permitted quicker installations of service for customers, it became apparent that the operation of telephone company storerooms was not the best answer for many places. The average large storeroom carried about 1000 to 1500 different types and sizes of telephone materials and tools, while the Western Electric Company distributing houses normally stocked two or three times as many. Rapid strides were being made in the field of transportation, freight shipments were being speeded up, commercial trucking concerns were starting to operate on close schedules, and the motor truck was rapidly coming into extensive use as a reliable medium of transportation. It was a logical step from the storeroom night-loading plan to the development of a distribution plan which enabled the supply organization to meet the individual employee's requirements directly from the stocks in the Western Electric distributing houses, thus eliminating, in the metropolitan areas, the need for storerooms. This direct distribution plan made available, to the field forces within daily delivery radius of the distributing houses, all of the large stocks maintained there by the Western Electric Company.

Under this plan the employee uses an imprinted requisition to order items needed for his particular job. These requisitions are collected each evening by the supply deliverymen, along with any recovered material, and taken to the distributing house. The following morning a telephone company supply man reviews the requisitions and passes them immediately to the distributing house people. The supplies are selected as ordered on each requisition, separately packed, and later checked by a telephone company supply man. These individual orders are then grouped by locations and delivery routes, and delivered that night to the respective garages and work trucks by the supply deliverymen. Under this plan the supplies are available for use by the employee on the morning of the second day after he orders them.

It is of interest to note that this plan has been developed in one company to the point where there are no storerooms in its entire territory, the Plant Department being supplied directly from the distributing house by means of a system of truck routes covering the entire state.

The Use of "Traveling Storerooms"

To meet the operating requirements in a number of large cities, a further refinement has been widely adopted. This is known as the traveling storeroom plan for serving station installers and outside repairmen in metropolitan areas. When the entire motorized plant force is served on a direct individual order basis, as related just above, there is an interval of one working day between the time the employee prepares the order and when he receives the supplies. With the use of traveling storerooms the supplies for the station forces are delivered the same night the order is prepared.

These traveling storerooms are large motor trucks with specially designed bodies equipped to carry four portable shelving units. Upon these is carried a carefully selected stock of over 400 different items of station supplies and commonly used hand tools. A space in the front of the truck body is used to carry individual orders for the construction forces and for returning material recovered from plant.

At each garage on his route the supply deliveryman selects from the traveling storeroom stock the items indicated on the supply orders left by the station forces, and places each order in a canvas bag, which he leaves on the employee's truck. He then picks up a similar canvas bag containing the items which the employee has disconnected and wishes to return; this is placed in the open space in the front of the traveling storeroom truck. The direct individual orders for the construction forces are placed on the line construction trucks and splicers' trucks and any recovered material left by them is also picked up. Each traveling storeroom supplies the work trucks in three or more garages each night.

Upon completion of a traveling storeroom's night route, it returns to the Western Electric distributing

SHELVES FILLED

These units are now ready to be rolled, with others, into the traveling storerooms

house, where its portable shelving units are removed from the truck to be restocked by the telephone company supply force. The truck itself, meanwhile, is available for some other daytime service.

Before the advent of direct distribution, it was necessary for the telephone companies to maintain large garages in order to obtain the supply advantages of the adjacent storerooms. The direct distribution plan has eliminated this requirement and it is now practical, from a supply viewpoint, to house the work trucks in small groups near the job throughout the cities. This decentralization of the motor vehicle fleet has produced some operating economies by reducing the non-productive time of men and trucks in traveling back and forth from the garage to the job.

Under the direct distribution plan, each garage is equipped with a small steel locker which contains a few of certain types of station items which are needed occasionally but not required every day; for example, coin collectors, long cords, loud bells, etc. These items serve all the station force working from the garage, thus eliminating the need for each man to carry a stock of them constantly on his truck. The supply deliverymen review the stocks in the lockers nightly, replacing any items which have been used during the day. Where required, occasionally used tools such as manhole pumps, portable generators, blowers, long extension ladders, etc., are neatly stored on racks in a small enclosed space equivalent to that occupied by one truck. Small stocks of telephone directories for use of the installation force may also be kept in this space.

Loading the Truck

Placing the portable shelving units in a supply delivery truck transforms it into a traveling storeroom

In the downtown business districts of most cities, it is neither practical nor economical to equip station installers and repairmen with motor trucks. Here the problem of supply distribution is of a different nature from that discussed so far.

Various methods have been used. For example, each installation and repair foreman would rent a small room for supply storage purposes, locating it as near as he could judge to the center of his local territory. Wood shelving was erected and the foreman ordered the supplies he needed for his force about once a week. This method had some drawbacks. The lack of factual data in deciding upon the location of these supply rooms in the downtown section of the city often necessitated walking long distances to the job assignments. The task of ordering, stocking, and returning supplies took considerable of the foreman's time, and the different arrangement of items at each location made it difficult for the men to find the supplies they needed when they were transferred from one location to another to meet the variations in work load.

Under the plan now in general use, the locker locations are determined by a detailed study of service order and station maintenance activities, without regard to the foremen's territorial lines. The volume of these activities is indicated, by city blocks, on a large scale map, and the centers of heaviest concentration are picked as the locations for the combined installation and repair supply lockers. These locations are usually in office buildings or stores. Steel lockers, which can be easily moved when the center of activities changes, are placed at each selected location, and stocked with predetermined types and quantities of station supplies. Both installers and repairmen use the same lockers, as much of the material used by these two force groups is identical.

In the downtown section of a typical large city operating under this plan, there will be about 20 locker locations serving about 160 walking installers and repairmen. These men secure their supplies for each job from the nearest locker. In general, no attempt is made to assign particular men continuously to specific locker locations and this permits shifting the force to handle sectional peaks in business without any supply compli-

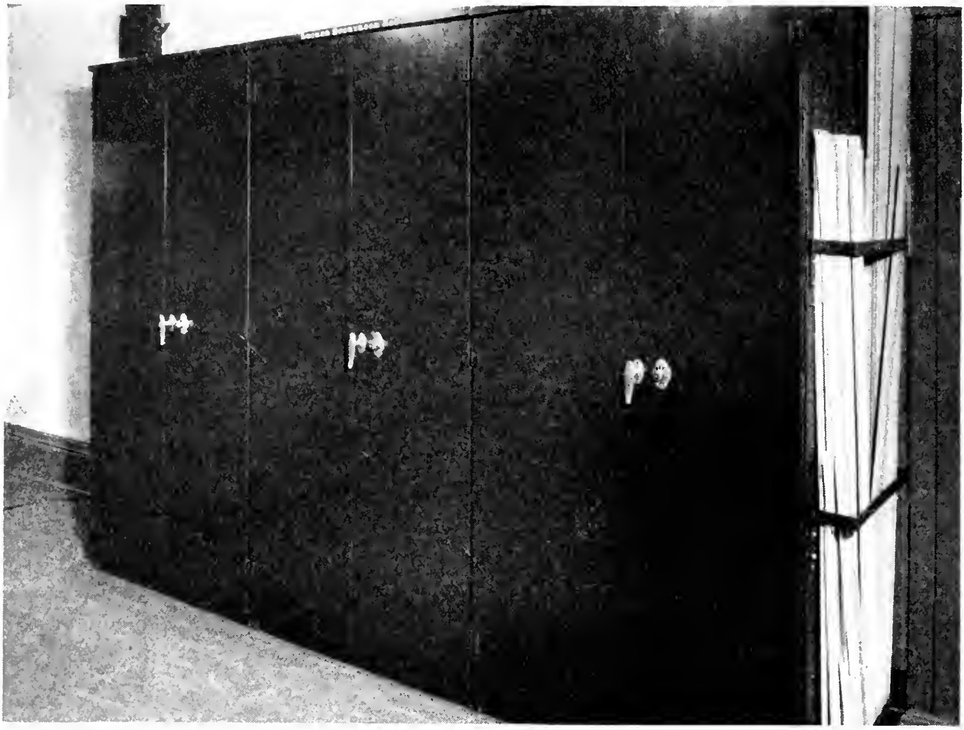
A TRAVELING STOREROOM IN OPERATION

From the shelves, requisitioned supplies are put in bags and placed on the work trucks in this typical garage, and items to be returned for reconditioning are picked up from the trucks at the same time

cations. It also reduces to a minimum the time spent by the employee in securing supplies, since he merely goes to the nearest locker for the items he needs. To aid the employee in locating the items, the supplies are arranged identically at every location and the shelving is labeled to show the name of each item and the authorized quantity.

Nightly the supply deliverymen with a traveling storeroom motor truck visit each location to replace the items which were used during the day and to pick up recovered material. It is not necessary for the station forces to prepare any orders for this material; the supply organization does the entire job. Under average conditions, better than 90 per cent of the customers' orders for service and practically all of the station maintenance work are completed with supplies secured from the regular stocks in these lockers. Large jobs, such as private branch exchanges, teletypewriters, etc., and requirements for unusual items, are handled on individual orders and the supplies delivered direct from the distributing house to the customer's premises in the daytime or to the locker locations at night by the supply organization.

Recently, as the telephone density has increased and the automobile traffic and parking problem has become more acute, the use of this



SUPPLY LOCKERS IN CONGESTED DISTRICTS

In downtown business districts, where traffic congestion makes trucks inefficient, lockers such as these are installed in convenient rented quarters where Plant employees on foot have access to them

locker plan has been introduced in the business sections of smaller communities and in apartment house sections in the larger cities.

FOR a number of years it was accepted practice for the telephone companies to maintain storerooms in all towns where Plant forces were stationed. In areas far from Western Electric distributing houses, where the distances precluded direct distribution, the aggregate of these many storerooms represented sizable stocks, floor space, and handling costs. The supply service rendered by these storerooms was not in keeping with other service improvements because of the impracticability of carrying in each one the wide variety of supplies normally required. This arrangement resulted in many emergency requisitions being sent to the distributing houses and in the constant transferring of wanted supplies between storerooms.

With the great improvement in transportation, it was a logical development in supplies distribution methods for the telephone companies to establish a supply center or centralized storeroom, carrying diversified stocks, at many of their district or division headquarters in the outlying areas. Each night the supply delivery trucks start from the central storeroom and visit the surrounding territory, delivering supplies to the work trucks, lockers, and buildings in the surrounding communities. Under this plan, the former inadequate small storage locations have been eliminated and a greater variety of supplies made available daily to the employees. Individual orders and traveling storerooms are both used for servicing these surrounding communities, dependent upon the telephone company's requirements.

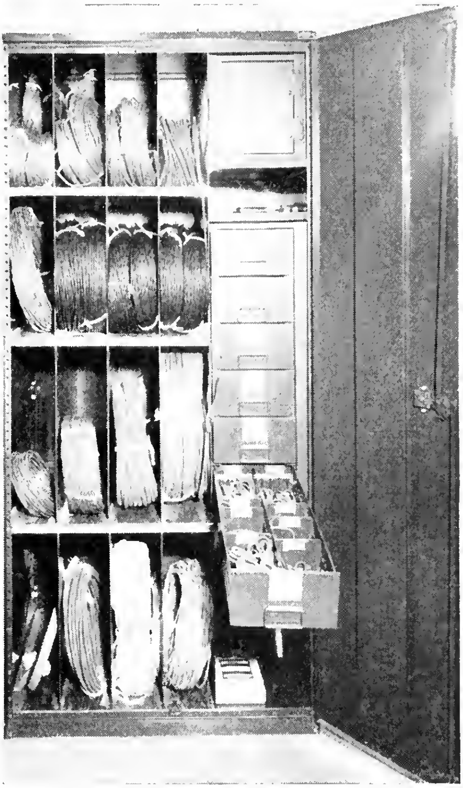
The stocks at the central storerooms are replenished weekly or more frequently from the Western Electric distributing houses, the supplies usually being shipped by fast freight or long distance commercial motor trucks.

Beyond the direct distribution areas and outside the areas served by the centralized storerooms are remote communities where local storerooms must continue to operate. However, even in these locations the trend is toward smaller and more frequent shipments from the distributing houses, plus night loading of work trucks, standard types and quantities of storeroom stocks, and more accurate forecasts of local requirements, all of which aid in giving better supply service from these modern storerooms.

Supplies for Dial Central Offices

FOR many years most telephone companies operated one or more storerooms devoted entirely to stocks of dial central office maintenance supplies. Despite the size of these stocks and the voluminous records required to maintain them, it was frequently found necessary to call upon the Western Electric Company to furnish additional items on an emergency basis. A few years ago, studies were made in some of the companies of the entire dial central office maintenance supply situation, and it was found that many items which were currently required were being ordered in bulk from the Western Electric Company, placed in storerooms, and redistributed from there to the central offices.

Here again, due to improvement in transportation facilities, it was found practical and economical to eliminate



EVERYTHING IN ITS PLACE

Interior of one of the lockers shown on the opposite page these specialized storerooms and improve the supply service by arranging with the distributing houses to fill the wire chiefs' orders directly. Infrequently used spare parts not stocked by the distributing houses are secured from the Western Electric Company manufacturing plants, if need be by air or railway express. Lists are prepared of the authorized types and quantities of the spare parts carried in the wire chiefs' lockers and the distributing houses. Ordering and delivery intervals are set up and included in the regular ordering and delivery schedules and plans developed for handling emergency requirements. This information is made available to all employees responsible for dial central office maintenance.

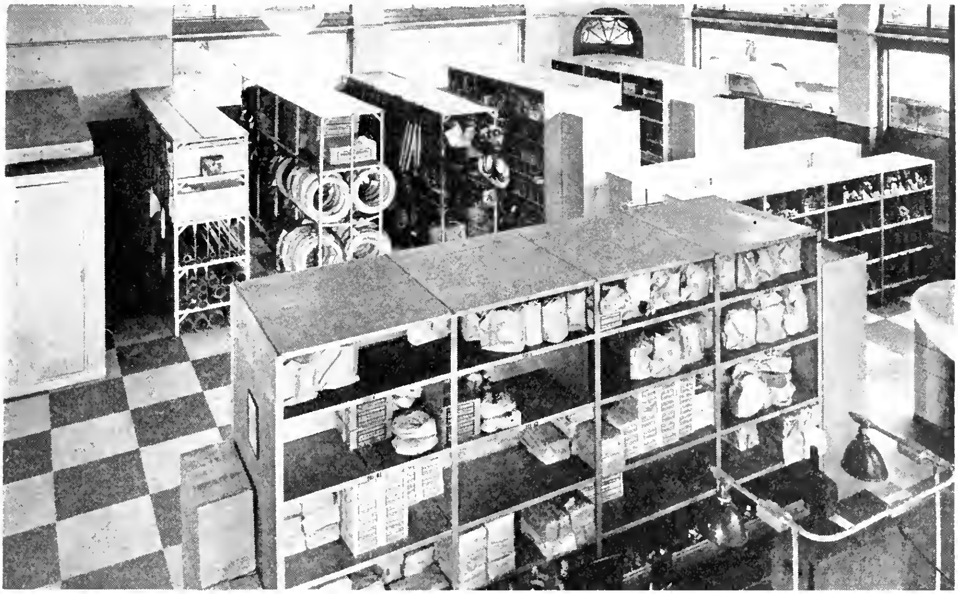
Building and Stationery Supplies

THE Bell System has a deservedly good reputation for excellent housekeeping in its buildings. While the men and women who do this job are by far the most important contributors to this spic and span appearance, the method of providing the cleaning supplies and other items used by them deserves some mention.

The modern plan of distributing building service supplies measures up to the appearance of the buildings. The requirements for each building are carefully studied. The amount of floor space, number of occupants, economical ordering quantities, and other important factors are used as a basis for determining the stock to be carried at each building. Well arranged lockers and shelving are labeled with the authorized quantities and types of supplies stored therein. Regularly, in accordance with the ordering and delivery schedule, a building employee reviews the stock on hand and compares it with the authorized quantity shown on the shelving labels. The difference in quantity, representing that which has been used, is inserted on a requisition form especially imprinted with all the commonly used items. This is sent to the distributing house and the supplies are delivered on the scheduled delivery day. Under this plan there is no guess work as to what and how much should be ordered; it is a simple clerical job easily performed by any employee.

THERE is hardly an employee of the Bell System who does not have occasion to use some items of stationery and printed forms in a normal working day. While the unit value of most of these items is small, in the aggregate they represent a considerable sum. In view of this comparatively low unit value, it is essential that the supply distribution plan operate in such a manner as to preclude, so far as practical, the necessity of placing orders for less than standard package lots. A close balance must be maintained between the value of the supplies being ordered, the average investment, and the cost of placing, filling and transporting the order.

During the past several years much progress has been made toward coordinating these elements, and the cost of distributing these supplies is being brought within practical limits as related to their value. Here again studies of the requirements at each



SUPPLIES ON HAND

This is a typical centralized storeroom serving a large rural territory

location enabled the telephone companies to set up authorized quantities and types of supplies to be carried. Stationery lockers at principal locations, with the shelving labeled with item names or form numbers and the authorized quantities, make the preparation of the periodic replenishment order a simple job.

In many companies it is customary to have stationery and printed forms stocked only at the district offices. The smaller locations and the individual employees are supplied from the district office stock as the needs arise.

What Happens in Emergencies

THROUGHOUT the Bell System the supply organizations have worked out, in coöperation with the operating departments and the personnel of the Western Electric distributing houses, smooth-running, efficient routines, adapted to conditions in their own territories, for getting supplies to their destined locations when and as they are required. And although this article is concerned principally with this routine of distribution under normal circumstances, the picture will be complete only if it includes some account of how supplies get to the man on the job when circumstances are anything but normal.

Floods, fires, tornadoes, sleet storms—all the catastrophic forces of Nature strike at telephone plant along with other structures of man's devising. No one can tell when or where the next blow will fall. But it is the tradition of the telephone industry to be ready always to repair the damage to its lines and equipment for the restoration of service just as fast as its resources, knowledge, skill, and man-power permit.

The Bell System's resources include, of course, stocks of all sorts of supplies, from wire and cable to switchboards and solder and paraffin wax, in Western Electric's distributing houses from coast to coast. Back of these are not only further reserves in Western Electric's factories and the factories of outside suppliers, but the manufacturing capacity and skill to turn out additional great quantities of all sorts of equipment and supplies from plants which readily gear up to day-and-night operation when the need arises.

To get huge quantities of these supplies to the telephone men in a stricken area requires a special knowledge in routing shipments from distant factories to the distributing houses and to sidings and freight terminals nearby. Around blockaded areas, in express cars hitched to crack passenger trains, in convoys of trucks, by boat, even by chartered planes, the supplies may flow to strategic points, where they are turned over to the telephone company's supply organization. Then over icy roads or through snowdrifts or around blocked highways or washed out bridges, they continue until they reach the plant men working along the lines to restore the service.

Instances of the abilities of the Western Electric Company and the telephone companies' supply forces to rise to an emergency are many. An illustrious one is that of the hurricane of September 21, 1938, when Western Electric delivered to the System operating companies in New England during the rest of that month and the first few days of October such quantities of supplies as—to cite but a few examples—607,000,000 conductor feet of lead-covered cable, 53,613,000 linear feet of drop wire, 16,632,000 prepared cotton sleeves, 2,039,000 pounds of pole-line hardware, and 21,800 telephone poles. Such quantities represent more than a year's supply of these items under normal conditions for the companies affected. Much of this material came, of course, from the distributing houses nearest the areas affected—particularly in the days immediately after the disaster. All of it had to be made available to the men on the job by the telephone companies' supply forces. Experienced supply men from other System companies were brought in to aid the local organizations, and, because of their practical experience with System distribution methods and System materials, were able to render immediate and substantial help to the local supply forces.

In the distributing houses, in times of emergency, work goes on as systematically as ever, but at greatly heightened tempo and often under most difficult conditions. If there has been a local power failure, night work continues under the beams of lanterns and flashlights, and men's backs carry loads when elevators are out of service. Typical of the will to maintain service was the instance of two men who lived for a week on the second floor of a distributing house whose ground floor was flooded, received orders by telephone, and passed stocks out the window to the

Operating Company's supply men who came alongside the building in boats.

THE men who direct the activities of the telephone companies' supply forces have their headquarters, as a rule, in the distributing houses. As in the normal routine, so in times of stress do the supply organizations work hand in glove with the Western Electric Company. Whether an emergency be major and widespread or minor and local, the telephone company's supply men are, because of their intimate knowledge of conditions in a given area, in a key position.

They must know transportation within their area, and have at their finger-tips lists of truckers to supplement their own vehicles and to undertake long hauls if the railroads are disabled. They must know at all times exactly where certain special cables and other vital equipment are stored. They must be well acquainted with all communities, so that they may readily locate temporary storerooms for supplies near to working forces. One way or another, with no lost time and with no lost motion, they must get the stocks where they are needed as they are needed.

Disasters are infrequent occurrences. But somewhere, every day, an emergency does happen—be it no more than a section of cable burned through by a blazing barn or a pole knocked down by an automobile out of control. Regardless of where the emergency occurs, and it may be hundreds of miles from the nearest Western Electric distributing house, the telephone companies' supply men must be able to produce at that location the cable or poles or whatever is required to mend the break. It is a matter of pride with every supply service man that no emergency restoration of service be delayed for lack of material. It is his job to get it to the spot—and he does.

PROVIDING materials under difficult conditions for the emergency restoration of service is dramatic. The day-to-day task of distributing supplies in orderly routine is not. But the supply organization which plays so great a part in enabling the Bell System to meet—and beat—emergencies, wherever they may happen and of whatever kind they may be, is the same organization which contributes to the smooth functioning of the telephone service by doing its normal, unspectacular job in thoughtful, intelligent, efficient fashion. To all the men who organize and direct and operate the ordering, stocking, and delivery of supplies, the maintenance of telephone service for the System's millions of customers is of first importance under all conditions.

THE CONQUEST OF A CONTINENT

The Successive Means Which Have Been Devised for Coast-to-Coast Communication Have Been Fundamental to the Growth of This Country and to Its Unity as a Nation

By ROBERTSON T. BARRETT

Part II*

Part I of the present study was devoted to a review of those facilities for overland communication between the Atlantic and Pacific coasts which antedated the use of steam for land transportation across the continent and the employment of electricity for the purposes of coast-to-coast communication. These included the famous Butterfield Overland Mail and the romantic Pony Express. With them were included, perhaps somewhat illogically, the Pacific Mail Steamship service, which was transcontinental only in a broad sense of the term, since its mails traversed only the relatively narrow Isthmus of Panama. Steam was, it is true, used in the vessels which carried these mails between New York and Panama, and between Panama and California and Oregon. As has been seen, after a relatively brief period during which mails were transported across the isthmus on mule-back, steam provided the motive power for this portion of the mail route.

But as a factor in the physical transportation of messages across the 3,000 miles that measure the width of the United States, the railroad does not appear in the history of transcontinental communication until relatively late. Indeed, as has been pointed out, the coast-to-coast telegraph line had already become an accomplished fact before the first railroad linked the Atlantic and Pacific seaboards of the United States. Let us, however, depart from a strictly chronological treatment of our subject and, before discussing the telegraph and other forms of electrical communication, briefly review the history of the railroad and the airplane as instrumentalities of transcontinental communication.

The idea of building a railway to the Pacific was almost as old as the railway itself, as an American institution. In 1832, when the nation's first locomotives were still a novelty, a weekly paper published at Ann Arbor, Michigan, had proposed it. Three years later, Samuel Parker gave impetus to the movement when he argued for the practicability of such a

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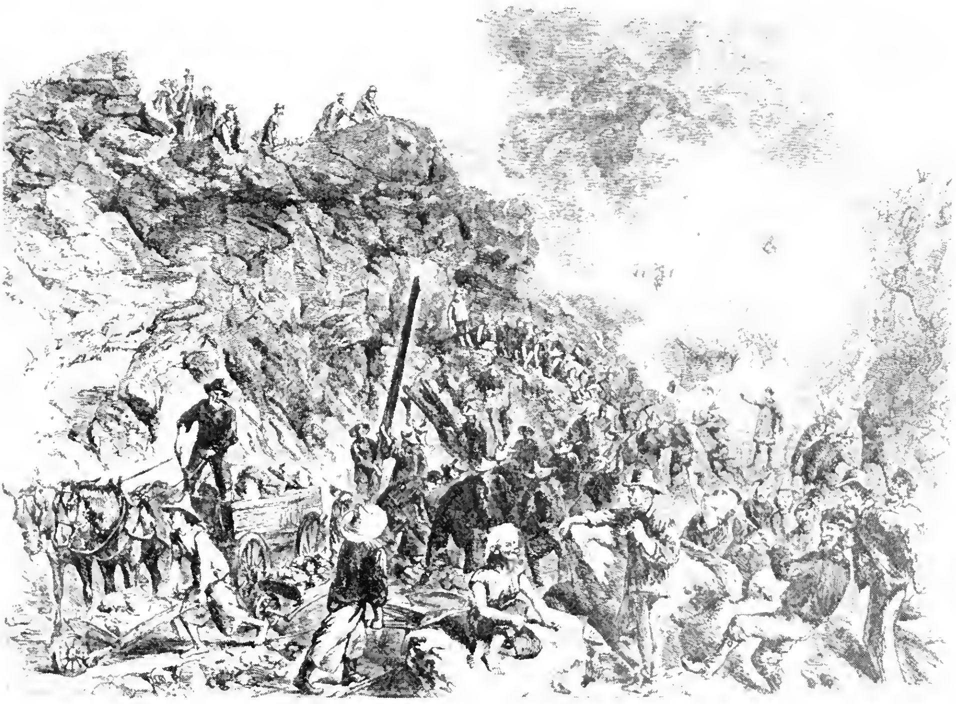
* Part I was published in the July issue.



BUILDING THE UNION PACIFIC

Work on the last mile of the pioneer transcontinental railroad saw the "mingling of European with Asiatic laborers," according to the caption of this contemporary drawing from Harper's Weekly

road, basing his statements on personal observations made during an overland trip from Buffalo, New York, to the Oregon country.

Some Pioneer Railroad Projects

TEN years later, Asa Whitney, a New York merchant who had spent two years in China between 1842 and 1844, came forward with the most concrete of proposals which up to that time had been offered. A part of Whitney's project was a scheme (which, to say the least, was ingenious) by which he proposed that the road be built under government sanction, but at no cost to the public treasury. Although this proposal is only indirectly related to the actual building of a transcontinental road, it deserves more than passing mention.

Whitney estimated the cost of construction at about $65,000,000—a cost, by the way, that was not far from that of the first coast-to-coast railroad, completed more than a score of years later. He proposed that Congress grant him a tract of land sixty miles in width, running along the proposed right-of-way, and extending from Lake Michigan to the Pacific. This land he proposed to sell to city dwellers at low cost, thereby combining a much needed social reform with the objective of providing transcontinental communication. The proceeds of these sales were to be applied to the cost of constructing the road. When finished, the railway was to be the property of the nation, and any profits derived from its operation were to be used for public education.

FANTASTIC though Whitney's scheme now seems, from a standpoint of financial soundness, memorials to Congress which he presented in 1845, 1846, and 1848 were given serious consideration, and his plan was endorsed by gatherings in numerous cities, as well as by the legislatures of sixteen out of the thirty states which then constituted the Union. There seems to have been in the man himself something of the fanatic, and yet in the following declaration, contained in his third memorial to Congress, there is evidence of the disinterested public spirit that, mixed with less altruistic motives, is the basis of all great communication enterprises. He says:

> "My desire and object have been to carry out and accomplish this great work for the motives, as here and everywhere else by me declared, to give my country this great thoroughfare for all nations without the cost of a dollar; to give employment to and make comfortable and happy millions who are now destitute and starving, to bring all the world together in free intercourse as one nation. If it is feared that the remuneration will be disproportionate to the extent and importance of the work, then I am willing to relinquish any claim I may have for compensation, and let the people give me anything or nothing, as they please. If they will but allow me to be their instrument to accomplish this great work, it is enough."

The route which Whitney suggested was, of course, primarily intended to link the newly settled Oregon country with the East. In considering his first two memorials, much thought was given to its political importance, and one Congressional report discussed the possibility that this distant region might organize itself into a separate nation if not linked to the rest of the country by better means of travel and communication.

California to the Fore

BUT before the third memorial came up for consideration, two events of far-reaching importance had occurred, either of which would probably have doomed the Whitney proposal. A war with Mexico had been fought and won, and vast territory, lying along the Pacific to the south of Oregon, had been acquired by the United States. Oregon was no longer the sole consideration in discussing plans for a railroad to the Pacific. Moreover, gold had been discovered in California early in 1848. The rush of treasure seekers—the famous "Forty-niners"—into the gold fields made it certain that, when such a railroad was built to the Pacific, its western terminus would be nearer than Oregon to the center of population of this newly developed area. Economic needs—and, later, political needs—were to determine the route of the projected coast-to-coast railroad.

Even as early as the date of Whitney's third memorial, in 1848, the same political factors which entered into the debate over the choice of route for the Overland Mail were making themselves felt. As sentiment for a railroad to the Pacific grew

AN INCIDENT OF RAILROAD BUILDING IN THE WEST

The jet of steam projected forward from above the engine's cylinder was the regular means of scaring buffalo off the track. (From a painting owned by the Union Pacific Railroad)

stronger, differences of opinion as to the location of its route became more marked. Sentiment swung, with changing Congressional majorities, from the northern route proposed by Whitney, to a central route, a southern route, or a compromise by the adoption of three routes. A historian of this period has said that it is difficult to determine whether the Pacific railroad project came nearer being talked to death by its friends than by its enemies. For more than a decade the controversy raged, and was not finally settled until the secession of the southern states gave the proponents of a central route a clear opportunity for action—and until that same secession had made action imperative.

Lincoln Signs the Railway Act

EVEN with the southern members absent from both houses of Congress, there was much wrangling over the terms of the legislation which led to the building of the first railroad to the Pacific, and it was not until July 1, 1862, that the Pacific Railway Act became a law by the signature of President Lincoln.

This act provided that the road was to run from Omaha to San Francisco.

The eastern portion of the line was to be built by a newly created corporation—the first since the Second United States Bank to receive its charter from the federal government. This was the Union Pacific Railroad Company. The section which it was to build extended from Omaha to the California state line. From this point westward to San Francisco, construction was to be undertaken by the Central Pacific Railroad Company, a California corporation. A government subsidy was offered in the form of a land grant—reminiscent of the Whitney plan—and a loan of the credit of the United States. The latter was necessary because the land grant could not be turned into immediate cash, for sales must await settlement, and settlement would be slow until the railroad was built.

With the details of how the building of the Union Pacific was financed, we are not, in the present discussion, greatly concerned. Time and space do not permit, and inclination does not prompt, an extended analysis of the Credit Mobilier, the operations of which were so intricate, to say the least, that eventually they were the subject of two Congressional investigations and became an issue of at least one Presidential campaign. The picturesque "Jim" Fiske and the not less striking figure of Jay Gould, who played a part in the history of the Union Pacific that was by no means inconsiderable, must be left for treatment elsewhere.

The Task Completed

Suffice it to say that, despite financial handicaps which were at times not less serious than those imposed by the nature of the country through which the road was constructed, the project was eventually completed. But progress was discouragingly slow. The Central Pacific began to build eastward from Sacramento in 1864, but by the early part of 1866 had laid down only fifty-six miles of track. The Union Pacific, building westward from Omaha, had completed only its first forty miles of track during the same period. Before these two companies had finished their work, the Central Pacific had constructed 689 miles of road and the Union Pacific 1,086 miles. On the tenth of May, 1869, engines of the two companies met at Promontory Point, Utah, and the picturesque ceremony of "driving the last spike" bore witness that America's first transcontinental railroad was an accomplished fact.

In dealing with the transcontinental railway as an instrumentality of communication, it is natural to think of it, first of all, as a carrier of mails. The report of the Postmaster General for 1869 shows that a contract with Wells, Fargo & Company for the transportation of the mails between the western terminus of the Union Pacific and the eastern terminus of the Central Pacific came to an end, under its own provisions, when the two railroads met on May 9, and were reported to be ready to carry the mails on the following day. It would appear that the historic ceremony of driving the golden spike was immediately followed by the far more important event of the actual transportation of mails, passengers, and freight over the newly opened line.

In a broader sense of the term, communication may be considered as in-

THE GOLDEN SPIKE IS DRIVEN

That historic ceremony at Promontory Point, Utah, has been completed, the locomotives from East and West have approached each other, and notables and spectators pose for their photograph. (From the Union Pacific collection)

cluding not only the carrying of messages, but the carrying of passengers, freight, express, etc.—the meeting of any needs, in other words, which arise out of the fact that two or more persons, who have relations with each other, are separated by the barriers of time and distance. Measured in terms of volume and of receipts from payments for their transportation, mails play an almost insignificant part in the service performed by such transportation instrumentalities as railways.

This fact, which still holds true in spite of the enormous increase in the amount of postal matter handled, is well illustrated by a summary of earnings of the Union Pacific for 1870, the first full year of its operation. In round numbers, these were: Commercial passenger, $3,528,000; Government passenger, $280,000; Commercial freight, $2,360,000; Government freight, $263,000; Company freight, $425,000; Express, $281,000; U. S. mail, $242,000. Thus it appears that, measured in terms of earnings, the transportation of messages was the least important function of the first coast-to-coast railway.

The Importance of Communication

PERHAPS this would be as good a place as any to point out, however, that while one of the functions of transportation instrumentalities is to enable people to travel, another is to make it possible for them to remain at home. This somewhat paradoxical situation arises from the fact that the letters carried by these means of transport are, virtually, substitutes for the persons who send them, and make the journey in their stead. So also with freight and express—the mere fact that carloads of oranges may be shipped from a distant state to New York makes it possible for millions of people in the latter city to experience the delight of tasting these fruits without journeying to their point of origin to do so.

It must be remembered, however, that communication, in its narrower sense, has a direct and significant bearing on the importance of the other services performed by the transportation facilities. Most passengers who travel across the continent by rail do so in accordance with arrangements they have made by mail, telegraph, or telephone. Practically every pound of freight or express that is shipped from coast to coast has been ordered by one of these means of transmitting messages.

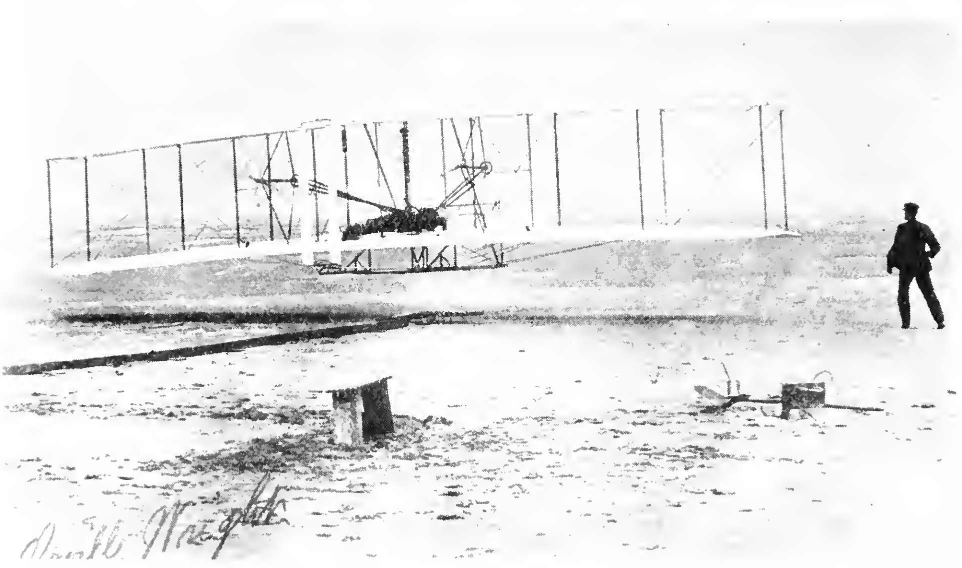
Because it met, for the time being, a national need which was, as has been indicated, a many-sided need, the Union Pacific prospered. But because this need was to grow too great and too urgent to be met by a single railroad, other lines to the Pacific were soon to be built—and, in course of time, a still swifter method of transportation was to be developed.

The Development of Aviation

AT exactly the time when gangs of coolies and Irish immigrants were laying the tracks for the first railroad to cross the western plains, two Germans, Otto and Langen, were experimenting with a contrivance which, when they had finally brought it to patentable form, became known as the internal combustion engine. Out of their pioneer work grew the automobile (with which, in our consideration of transcontinental communication, we are not greatly concerned) and the motive power which makes the modern airplane possible. As inevitable as was the fact that the railway should supplement, and later supplant, the post rider and the mail stage was it that the airplane should supplement the Railway Mail Service—though it has not supplanted it and probably never will. To this latest form of transportation, as an instrumentality of communication, let us briefly turn our attention.

The history of air transport, as a factor in communication in America, may be thought of as beginning in 1793, when Jean Pierre Blanchard, a French aeronaut, ascended in a balloon from Philadelphia, carrying with him a letter from President Washington calling upon all citizens to "receive and aid him with that humanity and good will which may render honor to their country and justice to an individual so distinguished by his efforts to establish and advance an art, in order to make it useful to mankind in general." The balloon remained aloft for forty-five minutes and descended at Woodbury, N. J., fifteen miles from its starting point.

Because of limitations inherent in its nature, the balloon never attained, as a means of communication, any degree of capability of being made "use-



CURTISS-WRIGHT CORPORATION

AN EPOCHAL EVENT

The Wright brothers' first flight, near Kitty Hawk, N. C., on December 17, 1903, lasted 12 seconds and covered 120 feet. In this picture, the only one taken of this momentous happening, Orville Wright lies prone at the controls and Wilbur Wright, running beside the plane, has released his hold on the wing as the craft leaves the ground. Note the autograph of Orville Wright at the lower left

ful to mankind in general." Whatever its form, the lighter-than-air flying machine was destined always to be at the mercy of wind currents—even after it had become a so-called dirigible. It was not until December 17, 1903, when the Wright Brothers lifted their frail craft from the sand dunes at Kitty Hawk, North Carolina, that man's real conquest of the air began.

NEARLY a decade was to elapse after the Wrights' first flight before serious consideration was given in the United States to the use of the airplane for the purpose of transporting regular mail. At an aviation meeting at Nassau Boulevard, Long Island, September 23–30, 1911, mail was carried between a temporary post office on the air field and the post office at Mineola, several miles away. In the same year Calbraith P. Rodgers made the first transcontinental airplane flight, from Sheepshead Bay, New York, to Pasadena, California. The trip took him forty-nine days, from September 17 to November 5, and was made up of a series of short flights, with many stops due to mechanical troubles or weather conditions. Progress in aviation was relatively slow until the use of the airplane for military purposes in the World War gave it great impetus. About this time there arose a demand for the use of this newly developed method of transport as an adjunct to the postal service. The first air mail route in the United States was established on May 15, 1918, between New

York and Washington, with a stop at Philadelphia for the exchange of mails and planes.

Transcontinental Air Mails

SERVICE over this route—admittedly established as an experiment—proved so satisfactory that the Post Office Department began to formulate plans for a coast-to-coast air mail. This service was built up by establishing, in succession, four "legs" of a route eventually connecting New York and San Francisco. The first of these, connecting Cleveland, Ohio, and Chicago, Illinois, with a stop at Bryan, Ohio, was inaugurated on May 15, 1919, exactly a year after the establishment of the New York-Washington route. On July 1 of the same year, New York was connected with Cleveland, with a stop at Bellefonte, Pennsylvania. On May 15, 1920—the second anniversary of the service—the third leg of the transcontinental route, from Chicago to Omaha, Nebraska, via Iowa City, Iowa, was established. Finally, service over the fourth leg, between Omaha and San Francisco, was inaugurated on September 8, 1920. The route passed over North Platte, Nebraska; Cheyenne, Rawlings, and Rock Springs, Wyoming; Salt Lake City, Utah; and Elko and Reno, Nevada.

Records show that the first westbound plane to fly this leg travelled at the average rate of eighty miles an hour and made the trip without a forced landing, either for weather or mechanical trouble. The plane carried 16,000 letters.

This flight, and those which followed for a number of years, were made in planes owned and operated by the Post Office Department. It will be recalled that the transcontinental communication services thus far described, although many of them were the beneficiaries of government aid in the form of mail subsidies or otherwise, were inaugurated and carried on as private enterprises. To this general practice the air mail was an exception. Initially it was a government-operated project. Post office authorities have stated that it was, however, never its intention to operate the service any longer than was necessary to demonstrate the practicability of commercial aviation and thereby induce private enterprise to enter the field and eventually take over the operation of the air mails.

THIS condition was deemed to have been met during the latter part of 1926. Early in 1927 a contract was let, after advertisement for bids, for the Chicago-San Francisco half of the transcontinental route. Under this contract, a company which later became the Boeing Air Transport took over operation of this route on July 1, 1927. The Post Office Department continued operation of the New York-Chicago section of the route until a satisfactory bid had been received from the National Air Transport, Inc. That company took over operation on September 1, 1927.

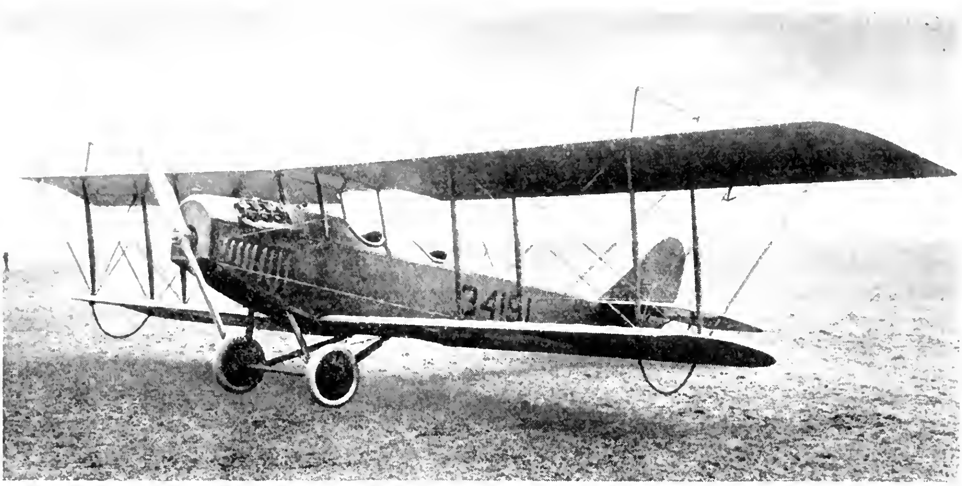
With the exception of a brief interval, when the service was reorganized in 1934 and the flying of the mails was assigned to pilots of the United States Army, operation of all air mail routes has since then been carried on by private concerns, under government contract.

SCENE OF THE FIRST AIR MAIL EXPERIMENT IN THE UNITED STATES

During an "International Aviation Meet" held at the Nassau Boulevard "aerodrome" on Long Island during September of 1911, regular mail-carrying flights were made to Mineola, L. I., where the mail sacks were "dropped in a field at the feet of the postmaster." (Reproduced from the Scientific American *of October 7, 1911)*

The inauguration of night-flying, made possible by the use of lighted air routes and various forms of radio apparatus; the increase in the length of "haul" that is possible without change of pilots or planes; vast improvement in equipment and personnel—all these and many other factors have contributed toward making the coast-to-coast air mail service what it is today. As of December 15, 1939, schedules issued by the Post Office at New York showed ten air mails a day from that city to various points in California; five to points in Oregon; five to points in the State of Washington. Typical of the time made by these coast-to-coast planes is that of one for which the mail closes at New York at 6 A.M. and reaches San Francisco at 2:40 A.M. the next day. Service from west to east is on approximately the same schedule as from east to west.

RATES for air mail postage over the transcontinental routes have gone through a period of transition. When the air service was first established, between New York and Washington, in 1918, the rate was twenty-four cents an ounce; this was later reduced to sixteen cents; then to six cents; and on July 18, 1919, the extra charge was removed altogether, air mail being carried at the regular domestic rate. In August, 1923, a zone rate was established with a charge of eight cents between New York and Chicago, a like amount between Chicago and Cheyenne, and another eight cents be-



A CURTISS JENNY

Open cockpit airplanes such as this carried the mail two decades ago, during the Post Office Department's establishment and operation of air mail routes

tween Cheyenne and San Francisco. On February 1, 1927, a new rate of ten cents per one-half ounce, regardless of distances, was put into effect, thereby doing away with the complicated zoning system then used on transcontinental and other contract routes. The present rate for each ounce or fraction thereof is six cents to any part of continental United States and Alaska. The rates to outlying islands and possessions vary between ten and fifty cents per one-half ounce or fraction thereof.

Air Passenger Service

THE development of air mail service gave marked impetus to the growth of passenger service as well, since the Act of Congress of February, 1925, empowering the Postmaster General to make contracts with private companies for carrying the mails, had the effect of granting subsidies for the development of both mail and transport service.

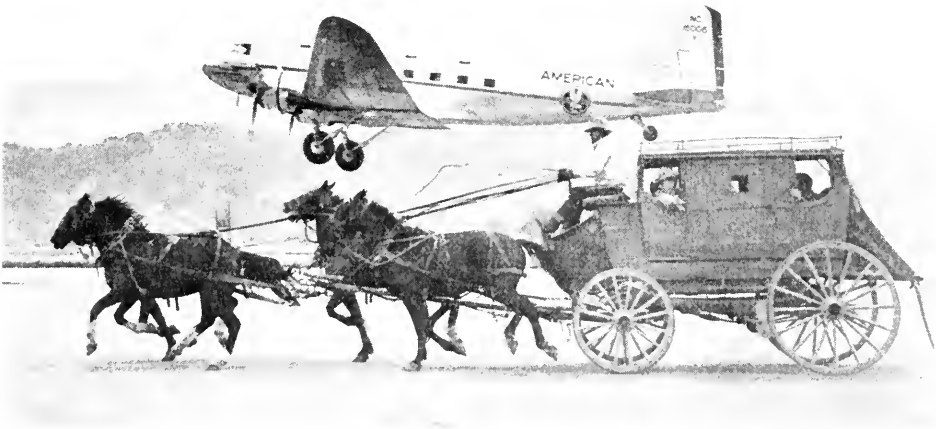
Various inter-city air transport lines were established, and it is probable that within a few years after the passage of the Congressional Act referred to above, it was possible to travel by air across the continent by making transfers from one line to another. The next step, taken in 1929, was an arrangement by which passengers were carried across the continent partly by airplane and partly by rail. Thus, passengers were carried from New York to Columbus, Ohio, by rail; from there to Waynoka, Oklahoma, by plane; thence to Clovis, New Mexico, by rail; and from this point to Los Angeles by plane.

About a year later, air passenger service entirely by plane was established between New York and Los Angeles, but an overnight stop was made at Kansas City, this being necessitated because, as yet, little progress had been made in promoting the practicability of night flying. From this point on, however, marked advances were made in the solution of the problem of providing twenty-four-hour service. The provision of larger flying fields, properly lighted, and the development of radio telephone and other communication services which contributed to the safety of flying in the dark, soon made it possible to inaugurate a service that was, in its main characteristics, like the transcontinental air transport service of today.

On August 1, 1932, United Air Lines inaugurated day-and-night passenger service between New York and San Francisco, with a flying time of twenty-six and three-quarters hours eastward and thirty-one hours westward. On November 5 of the same year, Transcontinental & Western Air, Inc., established a similar service between New York and Los Angeles. The flying time for the initial trips was twenty-four hours and forty-two minutes eastward and twenty-eight hours and forty-three minutes westward. According to a recent table, the quickest flying time for a scheduled flight from New York to San Francisco is seventeen hours and fifty-six minutes; from New York to Los Angeles, fifteen hours and eight minutes.

WITH this brief review of the history of the air mail, our consideration of those instrumentalities of communication which depend on the physical transportation of written messages comes to an end. The third and concluding portion of this study of the place which transcontinental telephony holds in the over-all picture of communication across the American continent will be devoted to those products of man's inventive faculty which, in one form or another, have employed electricity for the transmission of intelligence over distances.

(To be concluded)



FOR THE RECORD

T. K. SMITH ELECTED AN A. T. & T. DIRECTOR

At the meeting of the Board of Directors of the American Telephone and Telegraph Company on October 16, Tom K. Smith was elected to fill the vacancy caused by the death of David F. Houston on September 2. Mr. Smith is President of the Boatmen's National Bank of St. Louis, and has been a Director of the Southwestern Bell Telephone Company. Mr. Houston had been a Director since 1924. He became President of the Bell Telephone Securities Company in 1921, and from 1925 to 1927 was a Vice President of the A. T. and T. Company.

DR. BUCKLEY SUCCEEDS DR. JEWETT AS PRESIDENT OF THE BELL LABORATORIES

On October 1 Dr. F. B. Jewett, Vice President of the American Telephone and Telegraph Company in charge of research, resigned as President of the Bell Telephone Laboratories, becoming Chairman of the Board of Directors. Dr. O. E. Buckley, Executive Vice President of the Laboratories, succeeds Dr. Jewett as President.

There is no change in Dr. Jewett's responsibilities for the general program of research in the Bell System, but the change will increase the time he has available in an advisory capacity to the Government as President of the National Academy of Sciences and as a member of the National Defense Research Committee. Dr. Jewett has been the operating head of the research program of the Bell System for twenty-four years and responsible both for the program and its operation since the retirement in 1930 of John J. Carty, who at that time was Chairman of the Board of the Laboratories.

Dr. Buckley, the new President, joined the staff of the Western Electric Company in 1914, since when he has been intimately associated with telephone research. He became Executive Vice President in 1936, upon the retirement of Mr. E. H. Colpitts.

OPEN DIRECT TELEPHONE CIRCUIT TO SPAIN

Regular telephone service between the United States and Spain, suspended since the outbreak of the Spanish civil war in 1936, was restored on October 22 with the opening of a direct short-wave radio circuit between New York and Madrid. Previously, calls were routed over New York–London radio channels and completed their journey by cable and wire lines. The new channel also becomes the normal route for calls to Portugal, which at present travel via Rome and Berlin. It enables all Bell System and Bell-connected telephones in this country to reach telephone subscribers throughout Spain and Portugal. The radio link is jointly operated by the A. T. & T. Company and the National Telephone Company of Spain, a subsidiary of the International Telephone and Telegraph Corporation, which operates Spain's telephone system.

CONTRIBUTORS TO THIS ISSUE

In 1911, following three years at Lehigh University, **Raymond C. Silvers** joined the outside plant construction organization of the American Telephone and Telegraph Company. The next six years brought him varied experience in outside plant construction, maintenance, material supply, and engineering, during which time his association also included the Western Union Telegraph Company and the Western Electric Company. From 1917, when the Long Lines Engineering Department of the American Telephone and Telegraph Company was formed, until 1924, he was engaged in the engineering of the toll outside plant. Transferred to the Department of Operation and Engineering of the American Company in 1924, his present responsibilities are the outside plant engineering practices applying to the toll and exchange plant. He is the author of "Some Recent Advances in Rural Construction," which appeared in the Quarterly for October, 1939.

Entering Yale in 1914, **Judson S. Bradley** left college in 1917 to enlist in the U. S. Army Ambulance Service. Returning from overseas in 1919, he reentered college, and received his B.A. degree in 1920. For the next four years he was assistant editor and managing editor of the *Yale Alumni Weekly.* In 1925 he joined the Publicity Department of the Southern New England Telephone Company, in New Haven, as copy writer, and was subsequently advertising manager until 1928. In that year he was transferred to the Commercial Division of the American Telephone and Telegraph Company, and in 1930 became a member of the staff of the General Information Department. He has contributed several articles to the Quarterly, of which the most recent was "The Bell System Meets Its Greatest Test," in the issue for October, 1938.

Before joining the Bell Telephone Laboratories in 1929, **Franklin L. Hunt** had been for ten years a member of the staff of the National Bureau of Standards, where he was successively chief of the aeronautic instrument section, assistant chief of the engineering physics division, and engaged in x-ray research. In connection with aircraft instrument development work he spent a year in Europe as special representative of the Bureau of Standards. He had also been assistant manager of engineering and research at the Victor Talking Machine Company. Dr. Hunt received the degrees of S.B. and Ph.D. from Massachusetts Institute of Technology and of A.M. from Harvard, studied at the Universities of Paris, Berlin, and Cambridge, and has taught and lectured at Harvard, M. I. T., and George Washington University. He is a Fellow of a number of scientific societies and the author of papers on various scientific topics. At the Laboratories, Dr. Hunt was for several years in direct charge of work on sound picture recording and reproduction, and since 1935 has been a member of the Bureau of Publication.

Entering the Plant Department of the Bell Telephone Company of Pennsylvania at Philadelphia in 1918, **H. Carl Ruth** was appointed Supervisor of Supplies in 1926, and Superintendent of Buildings and Supplies in 1927. In 1928 he was transferred to the Diamond State Telephone Company at Wilmington, Delaware, as District Plant Superintendent. In 1930 he joined the American Telephone and Telegraph Company in the Plant Operation Division, where he is engaged in the development of supply distribution methods and related operations.

RECEIVING the B.A. degree from Lafayette College in 1907, and the LL.B. degree from New York Law School in 1909, ROBERTSON T. BARRETT practiced law until 1918, and for the next three years was engaged in newspaper work. In 1921 he joined the Information Department of the A. T. & T. Company, and since 1936 he has combined his duties in that department with those of Historical Librarian of the A. T. & T. Co. He is editor of the *Telephone Almanac*, and has contributed a number of articles to the QUARTERLY, the most recent being "The Telephone as a Social Force" in the issue for April, 1940.

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